THE JOURNAL OF PROSTHETIC DENTISTRY

VOLUME 3 JULY, 1953 NUMBER 4

UNIVERSITY OF MICHIGAN
FEB 16 1954
DENTISTRY LIBRARY

Official Publication of

THE ACADEMY OF DENTURE PROSTHETICS

THE AMERICAN DENTURE SOCIETY

THE PACIFIC COAST SOCIETY OF PROSTHODONTISTS

THE AMERICAN ACADEMY OF RESTORATIVE DENTISTRY

THE AMERICAN ACADEMY OF CROWN AND BRIDGE PROSTHODONTICS

Editor
Carl O. Boucher

Associate Editors
Raymond J. Nagle Chester Perry Roland D. Fisher
M. H. Mortonson, Jr. Stanley D. Tylman

Editorial Council
Louis S. Block, Chairman
Emmett Beckley George Hughes Chester Perry C. J. Stansbery
Roland D. Fisher Raymond J. Nagle Thos. E. J.Shanahan W. Les Warburton

Contributing Editors
C. H. Blanchard Wirt W. Curry Felix French Paul R. Oldham
Cecil H. Bliss O. M. Dresen Harold L. Harris M. A. Pleasure
George H. Chiles Sanders Fowler Richard H. Kingery Saul C. Robinson
Clyde H. Schuyler Vincent R. Trapozzano Lewis C. Turner

Editorial Advisor, Dental Materials
Mr. N. O. Taylor

PUBLISHED BY
THE C. V. MOSBY COMPANY, 3207 WASHINGTON BLVD., ST. LOUIS 3, U. S. A.

Copyright 1953 by The C. V. Mosby Company

TABLE OF CONTENTS ON PAGE TWO

Presenting two new prosthetic aids of major importance in your full and partial denture practice

THE TRUBYTE Bioform® MOULD GUIDE

You'll want this new Trubyte Bioform Mould Guide for a number of reasons — but mostly for the great convenience it provides to the busy practitioner. It will enable you to quickly and accurately select teeth for your full and partial dentures. It will save you time and money in resets and remakes. Here in one attractive case are all the available upper and lower anterior moulds of Trubyte Bioform Teeth, with complete information on dimensions and articulations.

THE TRUBYTE Bioform® SHADE SELECTOR ASSORTMENT

Here is the easy and practical way to select shades for full and partial dentures. It practically eliminates the resets, remakes and disappointments that often follow selection with a single shade guide tooth. Why not try this practical prosthetic aid today. It contains 1 x 6 of the twelve shades of the Trubyte Bioform Natural Tooth Color System — the only fully correlated system which offers a full range of selection for all ages and complexions.

THE DENTISTS' SUPPLY COMPANY OF NEW YORK

TEAR OUT AND MAIL TODAY!

PETER, STRONG & CO., INC.
207 East 37 Street
New York 16, N. Y.

Please send me without obligation Test Package of Benzodent, including literature, so that I may confirm to my satisfaction the research findings establishing the many values of the Benzodent Treatment to me and my new denture patients.

Dr. _____

Address _____

City _____ Zone ____ State ____

Send for

free test package of

BENZODENT

for your new denture patients

Benzodent is the new analgesic, germicidal, adhesive ointment for routine use with new dentures during the critical 5 to 21 day "breaking-in" period.

When applied according to clinic-tested directions to new dentures, Benzodent gives remarkable psychological and physiological adjustment and . . .

- **Saves chair time**—saves unnecessary adjustment and trimming
- **Gives patient comfort**—gives relief from sore spots and from pain and discomfort of new dentures
- **Controls gagging,** bleeding, infection, mouth odors
- **Effective 10 to 36 hours**—will not wash away

A product of
Peter, Strong & Co., Inc.
New York 16, N. Y.

The Journal of Prosthetic Dentistry

CONTENTS FOR JULY, 1953

Through the Eyes of the Editor. Carl O. Boucher, D.D.S., Columbus, Ohio 443

Difficult Denture Cases. Felix A. French, D.D.S., Ottawa, Canada. 446

Physical Considerations in Impression Making. Charles H. Moses, D.D.S., M.Sc. (Dent.), Toronto, Ont. 449

"Mucostatics"—Panacea or Propaganda? Chastain G. Porter, D.D.S., Kansas City, Mo. 464

A Criticism of the Present Approach to the Study of Prosthetics. A. O. Chick, Ph. D., M.D.S., Bristol, England 467

Reply to A O. Chick. F. W. Craddock, B.A., Dip.Ed., D.D.S.(N.Z.), M.S.D. (Northwestern), and H. F. Symmons, B. Sc. (Hons.), Grad. I.E.E., Dunedin, New Zealand 474

An Improved Impression Technique for Partial Dentures with Distal Extension Saddles. Emil H. Bollwerk, D.D.S., St. Louis, Mo. 476

A Theoretic Method of Occlusal Correction. Thomas D. Gilson, D.D.S., Ann Arbor, Mich. 478

Intraoral and Extraoral Phases of Dental Prosthesis. Joel Friedman, D.D.S., Brooklyn, N. Y. 493

Investment Changes During Flasking as a Factor of Complete Denture Malocclusion. Sigmund A. Perlowski, D.D.S., Kerrville, Texas 497

Attaining and Maintaining Mouth Health. Orville B. Coomer, D.D.S., Louisville, Ky. 500

The Influence of Saddle Classification on the Design of Partial Removable Restorations. Leonard S. Beckett, M.D.S. (Univ. of Sydney), Sydney, Australia 506

The ABC Classification of Partial Denture Segments. Joel Friedman, D.D.S., Brooklyn, N. Y. 517

Splints in Modern Dental Practice. The Group for Orthopedic Research in Dentistry, New York, N. Y. 525

Vents and Cups for Centrifugal Casting. Clarence H. Blanchard, D.D.S., Los Angeles, Calif. 538

Elimination of Wax by Vacuum for Partial Denture Casting. E. D. Shooshan, D.D.S., Pasadena, Calif. 541

How We Can Improve our Operative Dentistry. Russell W. Bassett, D.D.S., Beverly Hills, Calif. 542

The Application and Construction of the Pinledge Retainer. John F. Johnston, D.D.S., Indianapolis, Ind. 559

The Cement Applicator. Louis Alexander Cohn, D.D.S., New York, N.Y. 568

Progress Report on Full Implant Dentures. Isaih Lew, B.A., D.D.S., New York, N. Y. 571

Extensive Obturators. Commander Charles W. Miller, Dental Corps, United States Navy, St. Albans, N. Y. 576

American Board of Prosthodontics. I. R. Hardy, D.M.D., Boston, Mass. 582

News and Notes

Announcements 587

Vol. 3, No. 4, July, 1953. Journal of Prosthetic Dentistry is published bi-monthly by The C. V. Mosby Company, 3207 Washington Blvd., St. Louis 3, Mo. Subscription price: United States, its Possessions, Pan-American Countries, $9.00 per volume; Canada and other foreign countries, $9.50. Single number when available, $1.85. Entered as second class matter March 13, 1951 at the Post Office at St. Louis, Missouri, under the Act of March 3, 1879. Additional entry authorized at Jefferson City, Missouri. Printed in the U. S. A.

THE JOURNAL OF PROSTHETIC DENTISTRY

Vol. 3 July, 1953 No. 4

THROUGH THE EYES OF THE EDITOR

Felix French attacks problems which should be close to the heart of every dentist. What is our attitude toward our patients? What is our ethical responsibility? What is success? His analysis of the attitudes of some of those in the dental profession toward the vexing problems that arise in a prosthetic practice is excellent. His conclusion that the fulfillment of the fundamental requirements of prosthetics will show the way to success and satisfaction in practice is sound.

Charles H. Moses discusses a number of experiments related to the retention of dentures. Then he correlates these experiments to impression making. He questions some statements of other authors on the basis of these experiments, and there seems to be logic in his reasoning. He emphasizes the importance of intimate contact of the impression surface of a denture with the soft tissue (the same as many authors), but he recognizes the practical difficulties in attaining this intimacy of contact (different than some authors). He is quite right in his interpretation of the limitations imposed by biologic factors on impression procedures and denture retention. He concludes that atmospheric pressure is a factor in denture retention and that denture borders should be shaped accordingly. We suggest another reason for properly formed denture borders. Without them, it is impossible to restore the facial contours properly. He points out the importance of ridge form to retention. It is important, but it is more important to stability than to retention. Stability must be maintained to retain retention.

Chastain G. Porter gives his analysis of "mucostatics." He points out that it is not new and that its application accomplishes only a *part* of an effective retention for dentures.

A. O. Chick criticizes the present approach to the study of prosthetics on the basis that too much reliance is placed on the findings and observations of those who have preceded us. He urges that the work of the esteemed pioneers be rechecked in the light of further knowledge. He feels also that researchers should be more precise in their experimental methods and more accurate in reporting all of the details of the research. He points to the article, "Evaluation of the Face-Bow," by Craddock and Symmons (J. PROS. DEN. **2**:633-642, 1952) as an example of research with incomplete data.

Our own reaction is that too much research in prosthetics is done to *prove* a given concept, and not enough of it is done to *find out* the facts, regardless of what they prove.

F. W. Craddock and H. F. Symmons answer A. O. Chick's criticism by supplying the data which was omitted from their original article and by suggesting that it is possible to reconstruct the experiments and the mathematics with the information that was furnished. They agree that it would take more work than if the data had been furnished.

Emil H. Bollwerk described an efficient technique for impressions for partial dentures in his last contribution to dentistry. It is an accurate method for relating the impres-

sion of the soft tissues to the impression of the remaining teeth.

Thomas D. Gilson proposes a theory of occlusal correction and suggests a systematic procedure to follow in the determination and correction of occlusal disharmonies. He defines centric position in a manner which may be confusing because too much emphasis is placed upon the relations of teeth to each other. As we see it, "centric position" should refer to the relation of the mandible to the maxilla regardless of the relations of the teeth when the jaws are in that position. "Centric occlusion" seems to be a better term, and in the corrected occlusion centric occlusion should be made to conform to the centric position of the jaws. He also introduces the term "retrocentric position." This term is subject to the same criticism because it involves both tooth relations and jaw relations. It should be noted that a retrocentric position involves a forceful and unnatural retrusion of the mandible from the position of "centric relation" which implies a physiologic resting condition of *all* muscles that *protrude* or *retrude* the mandible.

There is merit in the orderly sequence that is suggested for the correction of occlusal disharmonies. If it is followed carefully, it can produce excellent results. We do question the use of abrasive paste for the final corrections. Abrasive pastes are unable to select the surfaces which they modify, and will, therefore, modify cusp height rather than the planes on which the cusps are moved in the grinding. The objectives seem to be good, but we feel that centric occlusion should be adjusted to coincide with centric relation, rather than to accommodate it. The technique requires time and care in its use, and the beneficial results make its application worth the effort.

Joel Friedman calls attention to the respective responsibilities of dentists and laboratory technicians in rendering prosthetic service. There can be no doubt that the dentist must assume final responsibility for the oral health of the patient. He therefore must recognize the biologic factors, and he must make the diagnosis and plan the restoration. The technician must know the physical properties of the prosthetic materials, and he must know how to use them correctly. The technician can be of great assistance in the rendering of prosthetic service by performing the mechanical phases of the restorations, provided the dentist does his part. This is a good guide for the division of labor between the dentist and the dental laboratory technician.

Sigmund A. Perlowski has made a comparison of the amount of incisal guide pin opening which occurs with different flasking procedures. His results indicate that a thin core of stone over the teeth permits less change than the other methods he used. It seems logical that the heat given off by the investing stone or plaster could change the position of the teeth. This approach to the problem should be given further study because of the limited number of controlled tests that were made.

Orville B. Coomer compares the objectives and the measures of success of the various branches of dentistry. He uses this comparison to point out a dangerous narrowness of viewpoint which is evident even in the general practitioner. He states that reconstruction is not the objective, but rather that the attainment and maintenance of complete oral health is the objective. He is more than correct when he insists that the mouth be treated as a unit of the entire organism and in proper relation to it. This is a fundamental requirement of modern dentistry.

Leonard S. Beckett discusses the support for partial dentures as related to the mucosa, the abutment teeth, and the power source for the mandible. On the basis of support he suggests a simple classification of partial denture situations. Partial denture saddles are divided into three primary types. Various combinations of these types make a total of seven groups which cover all of the various partial denture situations. The system seems to fill the need for a classification and to be simple enough to be practical. He relates partial denture design to the classification, even to the sequence of planning and assembly of the partial denture pattern. This is a step in the right direction. A classification is of no value unless it can be used as a tool.

Joel Friedman suggests a workable classification of partial denture segments. The bases are the location of the segments and the type of support of the segments. The

system is simple enough to be practical and usable. He suggests that it may serve as a guide to research. An attempt should be made to combine the good features of all the classifications so a universal classification could be adopted. Following that, basic principles of design can be related to the classification.

G. D. Kudler, R. Ritt, M. M. Lieb, A. A. Friend, J. E. Curry, and J. O. McCall have analyzed the role of splints in dentistry and oral orthopedics. They state the various purposes of splints and classify them from various viewpoints. The various types of splints and techniques for their construction are described. They point out the indications for each type of splint. They conclude that splints form an essential tool in modern dental practice. There can be little doubt of this if they are used correctly.

Clarence H. Blanchard suggests an easy way to provide a casting mold with vents. It should produce better castings. His second suggestion should save much gold that is lost in the laboratory.

E. D. Shooshan describes a method of wax elimination which will produce smoother partial denture castings. It also will prevent the formation of unpleasant odors during the burnout.

Russell W. Bassett points out many ways in which dental service can be improved. Specific recommendations are made, but, more important, a critical self-analysis is urged. Too often we become satisfied with the quality of the work we are doing, and soon discover that the quality is poor. It is an insidious process, a little laxity here, a slip there, and the work we do is not as good as we have done. The means for checking on the quality of dental service that are suggested will serve as helpful hints for better and more efficient service.

John F. Johnston discusses the use of pinledge retainers for fixed partial prosthesis. He has found that it is an efficient retainer when it is properly designed and used. The reports of his few failures emphasizes the importance of proper planning and extreme care in its use. He points out specific indications and contraindications for its use. These should be of value because of the large number of these retainers which he has observed. The technique for making and using these retainers seems to be sound.

Louis Alexander Cohn has described a new instrument for placing cement into cavity preparations when fixed restorations are being seated. The design of the instrument is such that cement can be placed accurately, even in difficult situations.

Isaih Lew makes a progress report on full implant dentures. He cites some of the changes in techniques and materials that have been made in the four and one-half years these appliances have been used. He estimates that over 400 implants have been placed, and that there have been some failures. He lists the causes of the failures, which should be helpful to those doing this work. One of the causes for failure is the improper selection of patients. It is too bad that this is necessary, since it is the debilitated patient who *needs* a service of this type most. The tissue sections which he shows are worthy of study. More of this type of research is necessary before implantation can become a standard procedure in dentistry. It must be recognized that denture implants are still in the experimental stage.

Charles W. Miller reports two cases where extensive obturators were required for rehabilitation of the patients. The extent and nature of the tissue loss in each instance required the utmost ingenuity for proper restoration.

—Carl O. Boucher.

DIFFICULT DENTURE CASES

FELIX A. FRENCH, D.D.S.

Ottawa, Canada

NOT SO LONG ago a young dentist asked me, "How do you recognize the difficult denture cases?" Since difficulties may arise from so many different sources, I was naturally interested to know what he had in mind and what prompted the question, before making any attempt to answer it. So I asked him what he meant by difficult. He said he just wanted to know how he could tell by looking in the mouth which cases were easy, and which were difficult. He said that he only wanted to do the easy ones, and had no desire to tackle difficult cases because they would take up too much of his time, unsatisfactory results would hurt his reputation, and he might not be paid.

It was quite obvious that his only interest in denture prosthesis was monetary and selfish, and that he had no conception of dentistry as a public service. It was equally obvious that, to him, difficult cases were not a challenge by which he could improve the quality of his work, or by which he could give genuine help to patients. His real interests were not in dentistry or people, but only in himself.

His reply was so far from what I had expected that it temporarily threw me off stride. My mind flashed back some thirty years to the day that two women came to my office, one of them in her late forties with her right cheek badly collapsed due to surgical removal of the right half of the maxillary arch. She had only six teeth remaining, the three upper left anteriors and the three lower right anteriors which, as she closed, glanced off each other forcing the mandible to the right, and accentuating the disfiguring depression on that side. With only half a ridge above and a narrow spiney one below, the outlook for satisfactory replacements was gloomy.

I told her frankly that I did not know whether I would be able to help her or not, but that I would like to try. With tears trickling down her face, she said, "You are the seventeenth dentist I have been to in the last eleven years and you are the first one that ever offered to try." She did not look like one who had much of this world's goods. I was not too busy, and was curious to know what might be done. The arrangements were that if I could help her she would pay what she could afford, and if I could not help her, she owed me nothing. The case proved to be easy. She was delighted with the result and returned in a few days to pay me fifty dollars and tell me she would gladly give me a thousand if she had it. She said I would never know what it meant to her to be able to go out in

Received for publication Feb. 21, 1953.

public without having people staring at her. We were both happy—she was rehabilitated and I had gained valuable experience.

It is true that some cases are easy and others quite difficult. We cannot, however, always judge which are the easy and which are the difficult ones merely by looking in the mouth. It is unfair to the patient, and very short-sighted, from the point of view of improving our own skill, to indulge in snap judgments.

Those with well-formed ridges in favorable relation and with a good uniform layer of investing membrane seldom present any difficulty. If the dentures we make for them are not comfortable, stable and efficient, it is our responsibility, and generally the result of faulty occlusion. Those patients with badly wrecked ridges, extensive alveolar resorption, the investing membrane an assortment of flabby flexible tissues, and the ridge relations unfavorable are not always as hopeless or difficult as they may appear. Naturally we cannot expect as good results as where the physical conditions are favorable. But with good impressions, correct centric jaw relation, the right amount of free-way space between the teeth in the rest position of the mandible, the occlusions balanced and functioning harmoniously with the jaw movements, it is surprising how well many of those patients do, and how satisfied and pleased they are with our work. Quite apart from the physical conditions in the mouth, there are many other factors that may influence the result. We sometimes see people wearing very badly constructed dentures with no apparent difficulty. They are healthy expert jugglers; while others with well adapted, well coordinated, properly constructed dentures are not comfortable or satisfied due to low tissue tolerance, a general health problem that must be solved before dentures can be comfortable.

Age is another factor. Young patients can wear almost anything. Elderly people are less robust and do not adjust so readily to new conditions. Women in their critical period of life sometimes present a problem that cannot be solved until the critical period has passed. Neurotics always present a problem to the dentist just as they do to the physician. Each case that presents to us lends iself to a certain result, and we should strive to get it. Where conditions are favorable, the result should be satisfactory. If it is not, we should look for some weak link in our technical procedures. Where conditions are not favorable, the patient may compensate by muscle control and adaptability for what may be lacking in other respects. We can promise less than we feel we can deliver and then do our best. When success does crown our efforts, we can be justly proud of the result, and the satisfaction of accomplishment may be greater compensation than the fee received.

While we can never hope to compare or compete with our Creator in supplying patients with efficient dentitions, we can, by ingenuity and by taking all the time necessary, give considerable help to nearly every patient. It is well to remember that in many difficult cases, the patients have been struggling with poorly constructed dentures which probably contributed to their condition. When we give them a carefully planned, properly adapted set of dentures that function harmoniously in the mouth, they will, by comparison with what they had, think they are in heaven. Dentures, to be satisfactory, must be comfortable in the mouth. They must look right, feel right, and be efficient in both mastication and speech.

There are basic principles underlying every step in our technical procedures from mouth preparation right through to the final balancing of the finished dentures in the mouth. These principles we should know. Then we must learn to apply them by building dentures for patients. In doing this, we encounter a variety of problems. For example, the requirements for esthetics may clash with the requirements for stability or masticating efficiency. This calls for the exercise of good judgment in making compromises in the most favorable direction. We may make mistakes, but we can profit from them by not repeating them.

We may know all the rules for safe driving and understand the working of all the gadgets on our car, but we must learn how to drive over bad roads as well as good, and through all kinds of weather, fog, rain, sleet, snow, and ice as well as in sunshine. No one is going to learn to drive well if he insists on driving only when the conditions are easy; no one can improve his prosthetic skill if he refuses to tackle difficult cases.

This may be learning the hard way, but there is no other or better way to acquire the skill and confidence necessary for the application of good judgment.

111 Metcalfe St.,
Ottawa, Ontario.

PHYSICAL CONSIDERATIONS IN IMPRESSION MAKING

CHARLES H. MOSES, D.D.S., M. Sc. (DENT.)

Faculty of Dentistry, University of Toronto, Toronto, Ont.

THE RELATIONSHIP of physics to denture retention and stability has not been investigated fully. There are very few known experiments either to confirm or deny some of the guesses at physical theory. As a matter of fact, there has been very little discussion of the physical factors involved. The few controversial theories that have been expounded have caused bitter recriminations within our profession.

ADHESION BY CONTACT, INTERFACIAL SURFACE TENSION

Let us begin by examining two glass slabs with water interspersed (Fig. 1). They will resist separation when a force is applied at right angles to the surface in an attempt to pull them apart. At this point the names of two men who have influenced impression making a great deal should be recalled. The first of these men is Wilson,[1] who made a serious attempt to study the physics of denture retention. He called upon the knowledge of physics of his day as he knew it, and attempted to relate the phenomena to dental problems. He became convinced that atmospheric pressure played no part in the retention of these glass slabs by placing them in a vacuum and proving that they will cling just as securely as they did in the air. Atmospheric pressure, therefore, played a secondary role, in his opinion, in the retention of dentures. He did, however, use it for what he termed an emergency vacuum and attempted to utilize it wherever he could.

He defined "cohesion" as the attraction of "like atoms which are brought into atomic relation to each other." "When the interatomic space is exceeded they can be held together only by adhesion, either by mass attraction or by an intervening adhesive substance."[2] He also pointed out that the thinner the liquid between the slabs the greater will be the adhesion, and formed the opinion, therefore, that the strength of the fluid was not the factor in the retention of the slabs.

Wilson concluded that intimacy of contact between the denture base and the mucosa with a thin film of liquid interspersed is ideal for the retention of dentures, and he called this "adhesion by contact."

The other man is not a dentist. He has influenced a section of the dental profession to such a degree that some of his theories will either have to be proved or disproved. I have, in the past, criticized the theories advanced by this man.[3] I still believe that his interpretation of the physics of denture retention is to a large

Read before the Academy of Denture Prosthetics at Ann Arbor, Mich., June 24, 1948.
Received for publication Feb. 26, 1953.

extent erroneous. But I believe that some of the concepts are practical, which is very different. Someone else may explain the physics more correctly, yet the practice may not be altered. Furthermore, the practice may prove to be correct.

I refer to Mr. Harry L. Page. An analysis of Page's writings[4] proves that he differs very little with the concepts advocated by Wilson and, much earlier still, by Richardson. He does, however, emphasize one salient feature of impression making so strongly that it is doubtful whether either Wilson or Richardson[5] recognized its importance.

Page ridicules Wilson's term "adhesion by contact." Certainly the term "mucostatics" is equally an unfortunate term because the mucous membrane is very far from being static at any time. This term was coined by Jones,[6] and evidently adopted by Page. He calls the phenomenon by which the glass slabs are held together "interfacial surface tension." Page states, "Interfacial surface tension operates by virture of a thin fluid film between two intimately contacted objects." In his opinion, it is the major force active in the retention of dentures. He also believes that this force is so great that it is the only one necessary to retain a denture.

Fig. 1.—Two glass slabs with water interspersed resist separation when force is applied at right angles to the surface.

Page also states, "The surface tension is inversely proportional to the thickness of the intervening film." In effect his conclusions are no different from those formed by Wilson. He gives as an example the fear of the manufacturers to pile sheets of plate glass upon one another because the power of surface tension would make it difficult to separate them. The inference is that there is a film of moisture between the plates. The Johannson gauge is another example given. He attributes the phenomenon of their great retention to a film of moisture between the objects. He claims that the film is very thin; that it comes from the moisture in the air. In all his explanations to the author, he indicated that moisture must be present between two objects for them to adhere. This part of his reasoning must be refuted.

There are attractions, without moisture. This is dependent upon the molecular relationship. The molecular forces with the *longest* range are Van der Waal forces which are effective up to a *maximum* distance of about 25 A.U. (angstrom

units) or 1/400 microns. At shorter distances other types of forces become effective. Such molecular forces are not directly involved in denture retention. This attraction need *not* be between molecules of the same kind. We are aware that pieces of gold foil are hammered into an intimate relationship and cohere. Page could not have seen gold foil restorations inserted or he would have found that moisture between the pieces would prevent this cohesion.

Godfrey, head of the Prosthetic Department of the Faculty of Dentistry at the University of Toronto, has kept two glass microscopic slides in optical contact for weeks by merely squeezing them together until at one round focal center they seemed to attach themselves together. In that condition they could be rotated around that focal point, and waves of refracted light form several rings of a wavy character around the focus (Fig. 2). Dr. G. D. Scott of the Department of Physics at our University had shown this to us and had expressed a doubt that moisture plays a part in the retention of these slides.

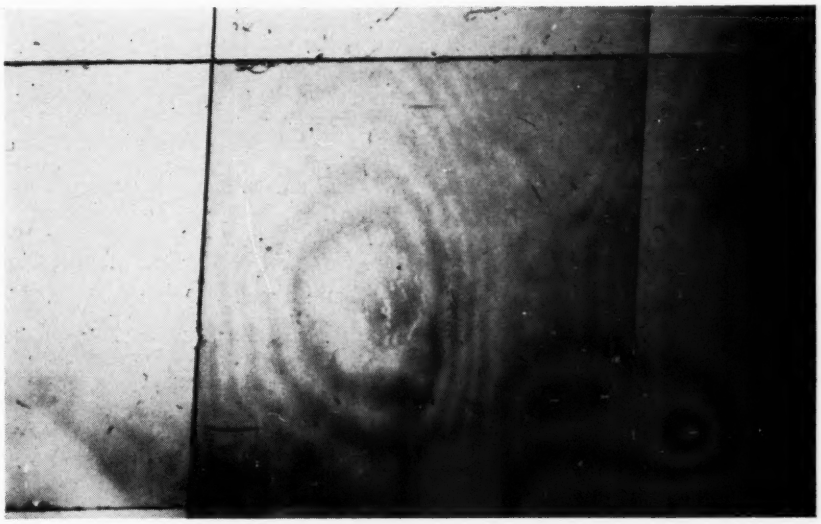


Fig. 2.—Optical contact. Two glass microscopic slides cohering about a focal point.

PHYSICS OF RETENTION

At this point some discussion of physics should be introduced. Some of this has no relationship to the retention of dentures. It should be discussed, however, because erroneous conceptions have been introduced. Let us begin with one or two definitions and a discussion of terms where definitions are not so essential. Scott is the authority for some of the definitions and explanatory notes presented.

Optical Contact.—This is contact between two solid surfaces in which, over an appreciable percentage of the area, the separation is very small compared with the wave length of light. This means that the surfaces must be optically smooth

and that there is no fluid air film between the surfaces. The molecules are sufficiently close that they attract each other as in a single piece of the solid. This phenomenon has *no* application in denture retention. This explains why sheets of plate glass cohere when piled on one another. It also explains the reason for the attraction of the faces of the blocks in Johannson gauges.

Scott states, "The Johannson gauges are carefully made blocks of metal used for measurements in precise machine work. The faces of the blocks are perfectly plane and well polished—these surfaces can be contacted optically so that two blocks can be made to stick together quite rigidly. There is *no* application of this principle to denture retention."

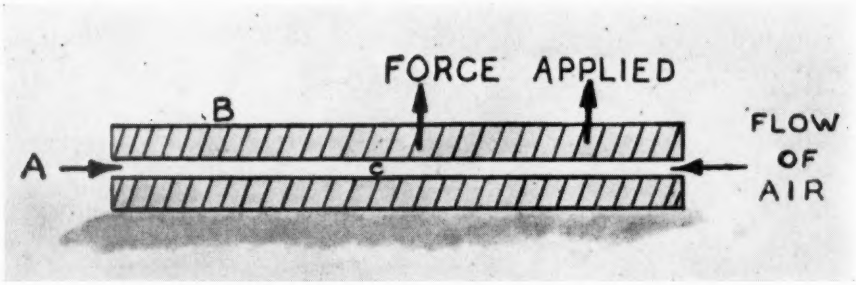


Fig. 3.—Glass slabs with only air between them.

Surface Tension.—This is the tangential force across a line of unit length in the interface between two fluids, usually a liquid and a gas.

Atmospheric Pressure.—This is the hydrostatic pressure due to the weight of the atmosphere upon the earth's surface.

Adhesion and Cohesion.—The dictionary definitions are adequate, no special physics being involved. Adhesion is used often for the sticking together of pieces of different substances. Cohesion generally refers to pieces of the same substance.

Capillary Attraction.—A phenomenon associated with surface tension which causes a liquid to wet a solid, e.g., water is "drawn up" by dry soil, oil by a wick, etc. In addition there must be a definite attraction between the molecules of the liquid and the molecules of the solid—e.g., canvas, ordinary and water-proofed, are quite different in this respect. Saliva might be more adhesive to some denture materials than to others.

There is much work to be done in this field. We have to understand why there is attraction sometimes and repulsion at other times. All molecules repel each other at sufficiently *small* distances. *That* is why solids and liquids are nearly incompressible.

Whether a liquid wets a solid or not depends on the chemical constitution of the liquid and of the solid. The presence of certain chemical radicals in the molecules are of particular importance.

SLABS WITH ONLY AIR INTERSPERSED

Let us leave our glass slabs with water interspersed for a moment and discuss two slabs fairly smooth with only air between them. The conditions are totally different. If the slabs cohere the factors governing that cohesion would be the area of the slabs (the greater the area the greater the cohesion), the shape of the area, the thickness of the air film, the viscosity of the air, the velocity with which they are separated, but *not* the materials. If there is no optical contact, the *maximum* force would depend upon atmospheric pressure. These slabs could not be held together in a vacuum if there is no optical contact.

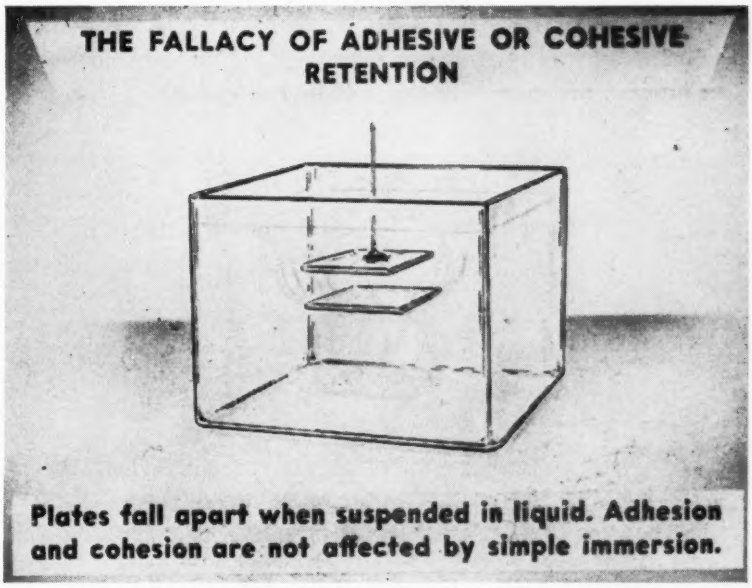

THE FALLACY OF ADHESIVE OR COHESIVE RETENTION
Plates fall apart when suspended in liquid. Adhesion and cohesion are not affected by simple immersion.

Fig. 4.—Plates do not fall apart as rapidly as Page suggests here. Courtesy Harry L. Page.

Moisture interspersed between the slabs would call for a different explanation. These two conditions are not to be confused. With only air separating these smooth slabs the explanation as to why they cohere for a time is as follows (we are assuming of course that there is no optical contact between the slabs) (Fig. 3):

In order to separate the slabs air must flow in. The diagram illustrates the circumstances. A force is applied which moves the plates apart. The pressure at C then becomes less than atmospheric; At A and B the pressure is atmospheric, thus pressure at B is greater than at C, hence the applied force is balanced.

SLABS WITH WATER INTERSPERSED

We now return to the glass slabs with water interspersed, for comparison. If we submerge the slabs in a tank of water, the conditions are the same as the cohering slabs in air except for the much greater viscosity of the water as compared

with the air. This means that it will take longer for a given force to separate the plates. Even with the immersed slabs, the maximum force required to separate them would be determined by atmospheric pressure in all cases. Atmospheric pressure is all around us. We cannot escape it. But in general the more viscous the liquid and the thinner the film between the slabs, the greater will be the force which can be sustained for a *certain time.*

Thus the plates do not fall apart as rapidly as we might believe from Page's illustration (Fig. 4). He claims that any excess of watery saliva would soon destroy retention. This is not quite true as we have already seen. Another reason is that it is difficult to parallel the conditions of slabs immersed in a tank of water to those of a denture. The lips and cheeks seal the periphery. If we argue that there is water intervening at the periphery even though it is very thin, we could also argue about the greater retention of the thin film. No, the conditions are not parallel. The liquid at the periphery does "seal" the borders.

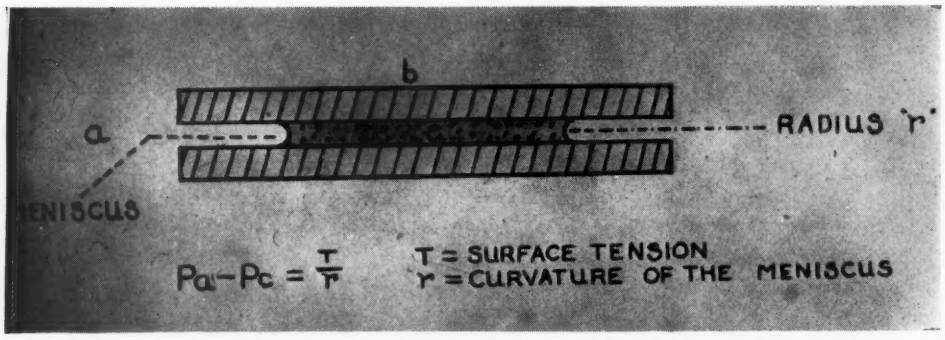


Fig. 5.—Glass slabs with water interspersed.

Next, if we assume that the plates are not immersed in water, but that there is merely a film of water between the surfaces of the plates, then the condition of equilibrium may be static rather than dynamic (Fig. 5). A given force may be sustained indefinitely as long as the water does not evaporate. The added effect is due to surface tension in the meniscus.

In this case, *without any* motion the pressure at c is less than that at a or b by an amount given by $Pa - Pc = \frac{T}{r,}$ where T is the surface tension and r is the radius of curvature of the meniscus. This added pressure will probably be quite small in most practical cases, but the effect of the meniscus in holding the film of water in place may be important. It may be as much as one-half pound in some mouths. We also see that the thinner the film of water, the greater would be the retention.

Some more physico-dental experiments will have to be done to establish the nature of the forces of retention. We shall also have to study the physics and chemistry of surfaces and their practical dental applications. This has not yet been done to my knowledge.

We observe that glass slabs may slide on each other very easily in a parallel direction while resisting separation at right angles (Fig. 6). This is important because even if we could produce an accurately fitting base that will adhere very closely to the mucous membrane and which will resist displacement at right angles to the ridge, we still have the danger of having it slide on the ridge if there are no stops. These stops are naturally present in the mouth at the flanges of both dentures, and at the distal inclines of the tuberosities of the upper denture.

Fig. 6.—Glass slabs although adhering when wet slide easily on one another.

Fig. 7.—Corrugated wet slabs do not adhere to one another to any great degree.

Intimate contact is a primary requisite. If slabs which are corrugated are employed they will not adhere to each other (Fig. 7). It would therefore appear that if we have intimately contacting surfaces like two smooth slabs with a thin film of moisture interspersed, and if we have stops to prevent skidding, all our troubles would be over. Generally speaking, they probably would be if the mouth could be compared with the glass slabs. But, unfortunately, this is not the case.

There are other factors which may create inaccuracies.

1. It is almost impossible to obtain an accurate impression of a denture-bearing surface because of the varying quantities of moisture covering it. In some areas, like the palate, there are many glands which secrete during impression making. It is almost impossible to keep saliva off the mandibular ridge.

2. The very introduction of a tray, no matter how small, into the mouth causes a distortion of some of the tissues.

3. Some of the softer tissues, being elastic in character, are displaced no matter how carefully the impression is executed, and this has a tendency to unseat the completed denture.

4. The materials employed in the construction of dentures are not absolutely accurate. This includes the impression materials, the artificial stones, the denture base materials, etc. A small gold inlay may be cast with a tight fit or a loose fit. A denture base is many times the size, and the variations are considerably exaggerated.

5. There may be errors in processing in spite of our best efforts.

6. Cellular contents are not constant. Tissues may be more edematous on the day the impression is made than on the day of the insertion of the denture.

7. There may be metabolic changes. Wilson claimed that dentures were loose when the patient was fatigued. So we see that we cannot compare the mouth with glass slabs. What are we to do with these factors which may create inaccuracies? I believe that we should call upon our old friend atmospheric pressure to assist us.

ATMOSPHERIC PRESSURE

There are some who will give this force all the credit for the retention of dentures. This was never taught by Richardson who gave us many fundamental principles, nor by Wilson. Page once rebuked me, pointing out that the average upper denture is about five square inches in area. Multiply this by 14.7, which is atmospheric pressure at sea level, and you have a force of 73.5 pounds holding up that denture. This, of course, is not the case. I never did claim that atmospheric pressure was the whole force. Neither Wilson nor any other prominent teacher claimed that it was the major force in denture retention.

No, this force is only operative on the tiny rivulets of inaccuracies that have occurred because our dentures cannot at the present time be made completely accurate. We must emphasize at this point that these spaces must be kept to a minimum. This requires an attempt to achieve accuracy throughout the entire procedure of constructing a denture.

Nature abhors vacuums and spaces, and attempts to fill them if she can. That is why the employment of relief chambers should not be encouraged. The smaller the error in procedure and materials, the less likely will be the danger of pathologic conditions because of voids. We all remember the effects on the palate produced by suction cups. If the voids are slight, it appears that the tissue which is pulled in by the atmospheric pressure need not be considered pathologic. Nature has many mechanisms for adaptation to new environments if she is not abused too much.

It is erroneous to state that atmospheric pressure is not necessary or is even injurious. It is needed for greater retention, particularly in upper dentures, and it need not cause pathologic conditions if it is kept within reasonable limits. Nature is kind to us that way. There generally is a *band,* not a line of tolerance, to which tissues can adapt themselves. If conditions are kept within that band, there will be physiologic adaptation. Of course, excesses could produce a pathologic result.

There is no need for some of the advocates of the so-called mucostatic principle to leave out the seal areas. They are afraid of producing distorted tissue which often results in an unseated denture when the tissue returns to its original form.

While the avoidance of tissue distortion is to be commended, it is not entirely practical. A seal at the post dam area of any "mucostatic" upper denture base will tighten it. I have confirmed this many times. The post dam seal operates so successfully because it is impossible to produce the accurately fitting upper denture base even though it is made under the most ideal conditions.

If the post dam is not too severe and the tissues are not distorted too much, it is very likely that there will be a physiologic adaptation. I believe that judicious sealing without causing pathologic conditions is a justifiable procedure. I must add, however, lest there be wrong interpretations, that I am thoroughly opposed to "beading" a denture indiscriminately. We must analyze the tissues and not pull them out of position for a distance beyond the limits of their capacity for physiologic adjustment.

ELASTICITY OF TISSUES

Since we are discussing physical factors that have a bearing on the retention of dentures, we must discuss the elasticity of the tissues. If it is not evaluated and neutralized it becomes one of the most aggravating factors in the disturbance of both the stability and the retention of dentures.

What do we mean by elasticity? "Elasticity is the property of a body which enables it to return to its original form after being distorted or deformed."

There are at least two reasons for the elasticity of the tissues. The first is that their cellular structure is in a shaped and defined form. The second is that there are elastic fibers which are more or less a part of all connective tissue.

We cannot study elasticity without differentiating between strains and stresses. If a body is so acted upon by force that a distortion or a change takes place and yet there is no motion of the body as a whole, that body may be paid to be strained. If a resistance takes place against the relative displacement of the particles of that body, the force causing that resistance is known as stress.[7]

Thus a loaded impression tray or a completed denture inserted into the mouth may cause the displacement of tissues that are loose and movable. These tissues may be said to be in a strained condition. Within the tissues themselves stresses are employed to counteract the strain.

If the periphery of a denture is overextended and stretches the mucobuccal and mucolingual folds beyond the rest position, the resisting pressure at the folds may be too strong for the other retentive factors, and by tending to return to the rest position, they may cause the denture to be loosened.

If the submucous tissues under the mucous membrane are soft and flabby and are displaced during the impression making, the tendency will be for them to resume their rest position. This force may unseat the denture. That is why impressions should be made with the tissues at rest or in their normal position. There will be no attempt by them to return to a previous form.

The forces of retention, although they are introduced by displacing tissues, may be too great for the elasticity of the tissues to overcome. In that case, the denture may be retained in spite of the displaced tissue. The potentiality of the tissues to adapt themselves to changed environment has been the salvation of living organisms. If the tissue tolerance at that time is at such a level that an adaptation of the tissue is possible through reorganization or some other process, the condition could be physiologic yet potentially pathogenic. If the strain is too great for the tissues, a breakdown may occur, and resorption or another pathologic condition may take place.

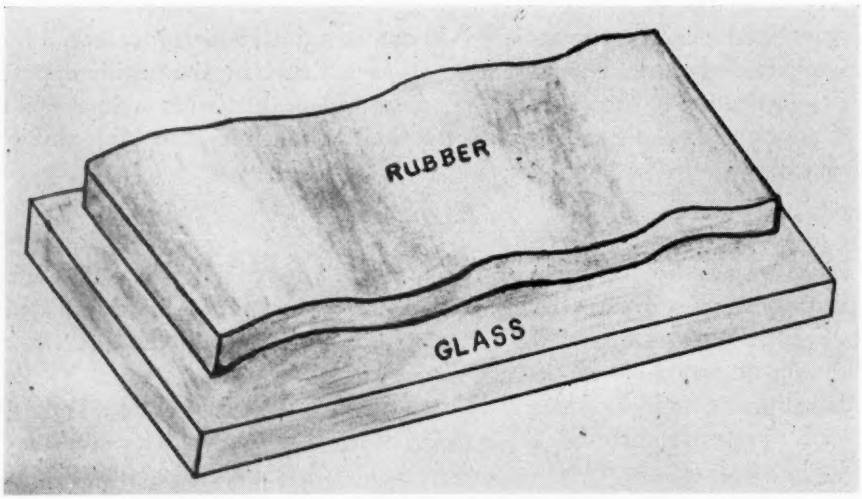


Fig. 8.—Irregular soft rubber slab placed upon smooth wet glass slab.

If we take two wet slabs, one being of glass which is smooth and the other of soft rubber that is somewhat irregular and ridged, we find that they separate easily if no pressure is exerted. This occurs because the contacting areas are too small. The rubber slab only touches on the high spots. If we press the rubber slab against the glass slab, straightening out the folds, it clings to the glass and remains straight. There is some force which holds the slabs together (Fig. 8). We may call it adhesion by contact, interfacial surface tension, or perhaps some other term might be more descriptive. The stress is attempting to overcome the strain, but the force is too great for it.

Harder rubber would overcome the force. The elastic memory of the rubber asserting itself would cause the rubber to resume its original form. The same process may occur either under a denture base, or at the periphery of a denture which has

been overextended, and is acted upon by the mucobuccal or mucolingual folds to displace the denture. Therefore, it seems logical from a purely physical standpoint not to displace tissue when making impressions. I have heard clinicians speak of "placing" the movable tissues of a ridge. When this is done strains are set up which tend to dislodge the denture base.

PASCAL'S PRINCIPLE

Pascal's principle may be described as follows: "Pressure exerted anywhere upon a mass of fluid filling a *closed* vessel is transmitted undiminished in all directions, and acts with the same force on all equal surfaces and in a direction at right angles to them."[8]

If impressions are made of tissues which are not displaced, stability is greatly enhanced. Page claims that Pascal's principle is employed in this manner.

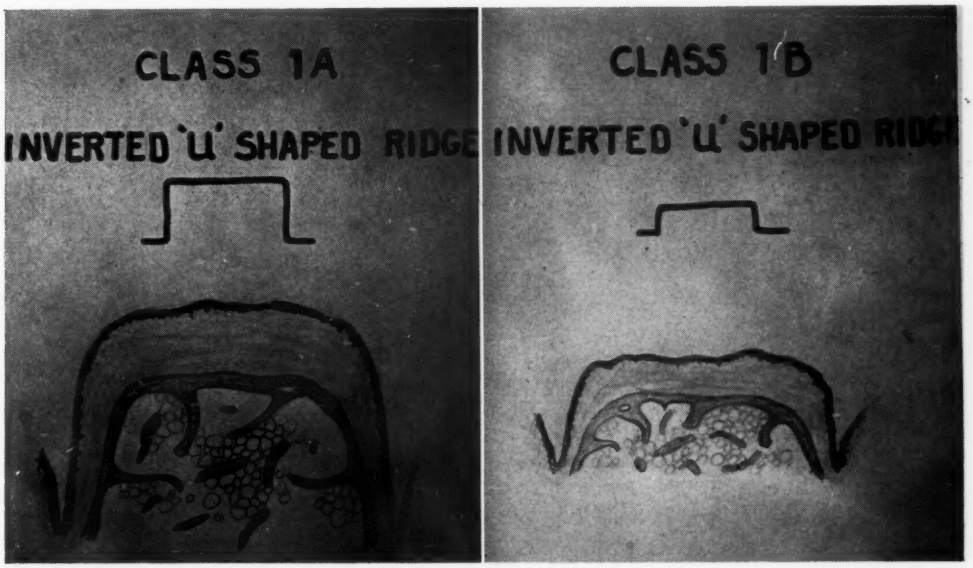


Fig. 9. Fig. 10.

Fig. 9.—Class *1A* ridge form.
Fig. 10.—Class *1B* ridge form.

When a denture base is resting upon an undisplaced ridge (the contents of the ridge being largely composed of water) the pressure is equally distributed in all directions. Therefore, there is virtually no give to the tissue within the ridge confined by the denture base. There are some who will argue that since there is a peripheral area around a denture, the tissue is not completely confined as in a cylinder. Granted. I will also add the argument that since there are so many factors that breed inaccuracy, the denture base will not be completely contacting, and, therefore, pressure upon the base will distort or displace tissue within it. This argument is not too practical. Just because we cannot obtain complete accuracy does not mean that we should not accept near accuracy. It is still better than the inaccuracies of previous methods.

One may make an impression of a very flabby ridge that is a true negative of the tissue in repose. After an accurate base is made, it will be found that there is little or no resiliency when pressure is exerted upon the base. The denture base feels as though it were sitting upon firm hard tissue when pressure is applied.

Pascal's principle is not effectively applied when impressions are made of displaced tissues. The ability to return, fully or in part, to their original form causes the denture base to lift leaving uncontacted areas.

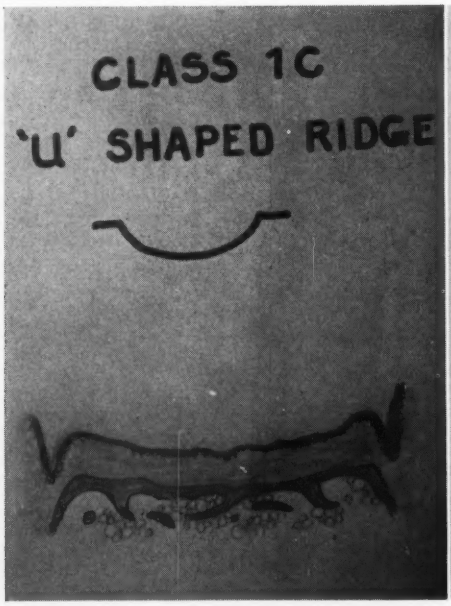


Fig. 11.

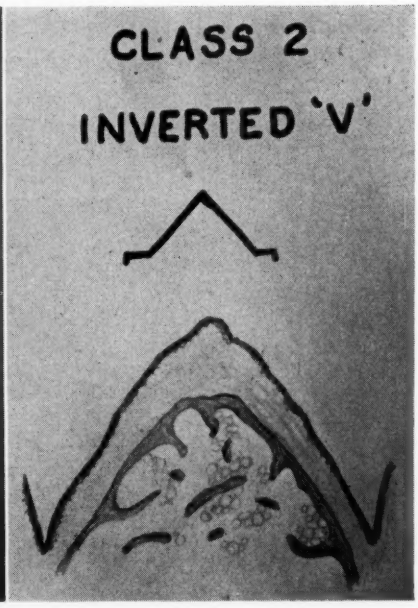


Fig. 12.

Fig. 11.—Class *1C* ridge form.
Fig. 12.—Class 2 ridge form.

FORM AND RETENTION

In a discussion of physical considerations of retention, ridge forms and their influence on the retention of dentures should be considered. One should be able to predict the degree of retention by the shape of the ridge.

Class 1A. Inverted U-Shaped Ridge.—The inverted U-shaped ridge permits a very retentive lower denture (Fig. 9). The sides are parallel, and when the denture slides upward it hugs them just like the glass slabs previously mentioned. At the crest, there is a fairly flat surface similar to the glass slabs being pulled apart at right angles to the surface. This, of course, resists separation. Should it separate, a vacuumatic space is produced at the crest of the ridge because the flanges still hug the walls due to their parallelism. This type of ridge produces a fairly snug denture.

Class 1B. Flat Inverted U-Shaped Ridge.—The flat inverted U-shaped ridge presents shorter parallel walls (Fig. 10). It, therefore, resists dislodgement for a

short distance only when the pull is on an upward direction. After that the entire denture leaves the ridge. There is a tendency for the denture to slide since the flanges are short.

Class 1C. U-Shaped.—The U-shaped ridge (Fig. 11) presents very little retention in comparison with Class *1A*, but it will resist displacement in an upper direction. It will have a tendency to slide. Articulation must be very accurate in these cases to prevent movement.

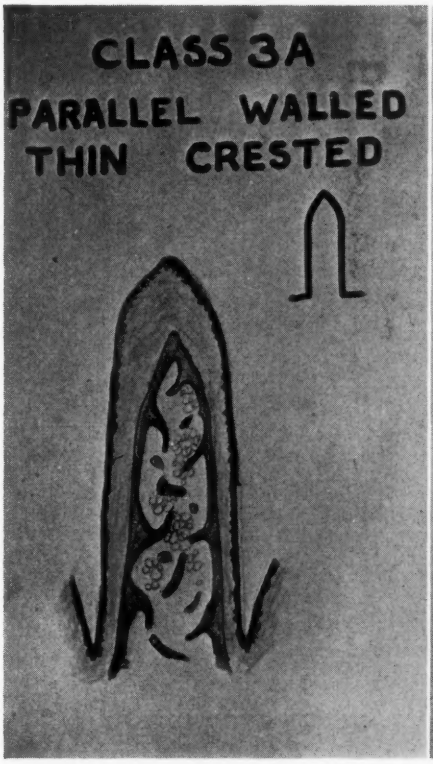


Fig. 13.

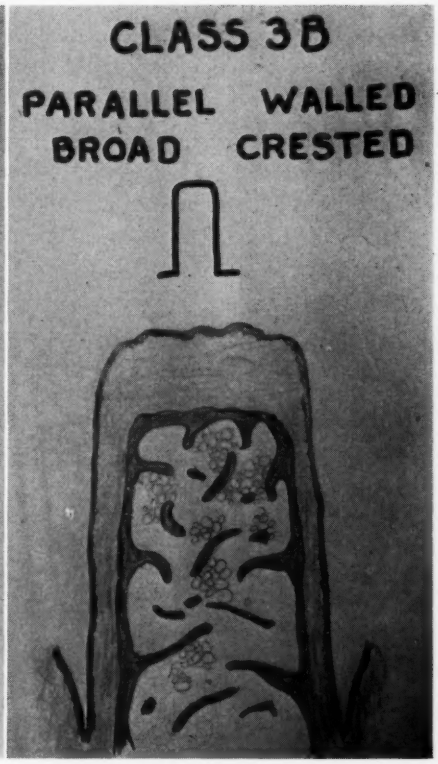


Fig. 14.

Fig. 13.—Class *3A* ridge form.
Fig. 14.—Class *3B* ridge form.

Class 2. Inverted V-Shaped Ridge.—The inverted V-shaped ridge is probably the least retentive of all (Fig. 12). The moment the denture moves in an upward direction it leaves the entire ridge at once. There is no parallelism. Also, the direction of force is such that separation from the ridge is easier. It is like two glass slabs pulled apart at an angle.

Class 3A. Parallel-Walled Thin Ridge.—The retention is not very great in a parallel-walled thin ridge because of the small area at the crest of the ridge (Fig. 13). Although the parallel walls of the denture hug the sides of the ridge and create some slight vacuumatic space, this is too small to account for much of the retention. In addition, there is not the retentive feature of two flat glass slabs

being pulled at right angles. These ridges when examined on a mandible show knifelike crests, and the walls are not actually parallel but are slightly V-shaped. It is only the fibrous tissue around the crest which nature placed upon these bones that gives them an appearance of being parallel.

Class 3B. Parallel-Walled Ridge, Broad-Crested.—The broad-crested parallel-walled ridge is the most retentive of all (Fig. 14). It is a combination of the longer parallel walls and the broad crest. The broader crest has the two features of creating a vacuumatic space as well as resisting separation like the glass slabs with the direction of force at right angles.

I formerly classified flabby ridges as Class 4. Since I distort less tissue with my present method of impression making, I have found that flabby ridges play very little part in disturbing denture stability or retention.

Though Richardson had called attention about seventy years ago, to the fact that impressions should not displace tissues and though others have shown techniques that called for light pressure, the proponents of "mucostatics" placed greater emphasis upon the subject. Light pressure is not sufficient. We should attempt to obtain a negative reproduction of the tissues at rest. This means no pressure at all. This is, of course, impossible to achieve, but it gives us something to strive for. This is the most valuable feature of the "mucostatic" principle and it is a good one. It conforms to both physical and physiologic requirements.

FRICTION

There is one other physical factor that I should touch upon and that is friction. The frictional retentive factor becomes evident when a reline is performed by placing a material into a denture and inserting it into the mouth. If we employ modeling compound, we notice that the denture becomes much snugger immediately, since the inner diameter becomes smaller than the diameter which the denture had before the modeling compound was inserted. Some tissue had to be displaced to make space. By means of this crowding there is some frictional retention.

My experience has been that this lasts only for a short while before the tissue alters. The zinc oxide-eugenol pastes have the same result, but they are less viscous. It is dangerous to count upon friction as a retentive force because of the tissue destruction which might occur. Nature would tolerate a slight amount of frictional retention, if it were not overdone, and the circulation pinched off.

CONCLUSIONS

1. There must be no displacement of tissues insofar as it is possible to avoid it.

2. If displacement is necessary at the peripheral borders to take advantage of atmospheric pressure, the degree of displacement must be minimized so the elastic force is not greater than the retentive force.

3. There must be an intimate contact between the denture base and the ***undisplaced*** tissues. This produces the thin film of saliva.

4. Physiologic seal areas are advantageous because atmospheric pressure is an important adjunct to denture retention.

5. Ridge form is an important factor in the retention of dentures.

6. The area covered by the denture is a factor in retention. The greater the area covered the greater will be the retention.

7. The viscosity of saliva is a factor in retention.

8. Friction could be a factor, but it is not recommended because of the pathogenic conditions it introduces.

REFERENCES

1. Wilson, G. H.: A Manual of Dental Prosthetics, Philadelphia and New York, 1917, Lea and Febiger.
2. Wilson, G. H.: A Manual of Dental Prosthetics, Philadelphia and New York, 1917, Lea and Febiger, p. 301.
3. Moses, Charles H.: A Critical Analysis of the Factors in the Retention of Dentures, D. Digest **52**:136-141, 1946.
4. Page, Harry L.: Mucostatics—a Principle, Not a Technique, Chicago, 1946, Published by the author, Harry L. Page, 1625 East Washington St., Chicago, Ill.
5. Richardson, J.: A Practical Treatise on Mechanical Dentistry, Philadelphia, 1894, P. Blakiston Son and Co.
6. Page, Harry L: Mucostatics—a Principle, Not a Technique, Chicago, 1946, Published by the author, Harry L. Page, 1625 East Washington St., Chicago, Ill.
7. Smith, C. J.: Intermediate Physics, New York, 1932, Longmans, Green & Co., p. 101.
8. Merchant, F. W., and Chant, C. A.: Mechanics, Toronto, 1931, Copp Clark Co., Ltd., p. 240.

45 Avenue Rd.
Toronto, Ont.

"MUCOSTATICS"—PANACEA OR PROPAGANDA?

CHASTAIN G. PORTER, D.D.S.

Kansas City, Mo.

THE TERM "Mucostatics" is a coined word, currently used to designate a theory of impression making and denture base construction, in which the ridge tissue is maintained in an undisplaced, undistorted, or passive form. With the exception of treatment accorded the postdam areas, few will challenge this principle, which is certainly not of recent origin. The premise, however, that the registration of surface minutia is of paramount importance, even to the exclusion of factors of equal or greater significance, denotes an appalling lack of understanding of the fundamental physical factors governing denture retention.

Mr. Harry Page is credited with originality of the "Mucostatic Principle" although Pryor[1] observes that "Drs. Montgomery and Burgess, of Los Angeles, claim originality for the mucostatic technic—later these gentlemen filed a lawsuit against Page for commercializing on his technic, trays, etc., resulting in a financial settlement made out of court." Mr. Page, a layman, who is characterized as "uninitiated" by one of his followers,[2] is apparently concerned only with an impression of the tissue on or near the crest of the ridge, and certainly not the placeable, looser tissue approaching the usual border termination.

In a brochure published in 1946 and distributed by a commercial concern, Mr. Page[3] states: ". . . the depth, detail and outline form of flange has no retentive value." The border extension of "Mucostatic" bases are greatly shortened and are likened, seriously, by one of Page's adherents[4] to the flanges of a railway car wheel, functioning only to prevent lateral displacement or jumping the track, a comparison which reaches a new high in absurdity.

On the contrary, maximum area coverage, extending to, but not encroaching upon functional tissue attachments, provides for a greater utilization of the forces of adhesion and atmospheric pressure, as well as for wider distribution and support of masticatory stresses. Such extension prevents food material from lodging at the denture border, renders these borders less discernible to the tactile sense of the tongue, maintains facial contour, and invites the retaining aid of the surrounding muscles of the face.

It has been the common knowledge of all dentists who have perused the literature since at least 1886[5] that the primary factor of retention is adhesion by contact of closely adjacent surfaces. From the era of Haskell and Richardson down to the

---

Reprinted from Kansas City Dental Society Bulletin **23**: 7-9, 1947, and Journal Missouri State Dental Association, 67-68, March, 1947.

present time, authors of textbooks—Wilson, Campbell, Schlosser, Swenson, Sears—have concurred with this basic fact. Atmospheric pressure is likewise recognized by these writers to be an auxiliary, secondary, but still important factor of retention. Atmospheric pressure, correctly applied, is a transient factor operative only when dislodging forces of mastication are brought to bear. This auxiliary factor, which is as helpful as a lower gear on an automobile, when a steep grade is encountered, is of course made possible only by correct physiologic border extension. Investigators in the field on anatomy—Pendleton, Harris, Neil, and Boucher, and their predecessors—have delineated a denture base outline forming the very basis of scientific impression making. In place of these precepts, Mr. Page has, by substitution of the term "interfacial surface tension" for the well-understood word adhesion, and with complete disregard of the work which has gone before, expounded a new "principle" of denture retention. Mr. Page apparently assumes an attitude of mild amusement, mingled with pity, at the plight and lack of understanding of professionally trained dentists. His description[6] of "Any major dental convention" in which ". . . no two follow the same idea, all are in conflict," is believed to be gross exaggeration. His statements,[7] "The dentist who attends, in an attempt to learn, is buffeted hither and yon by all kinds of diametrically opposed claims," and, "He can only return home baffled and confused," are, to say the least, uncharitable. One wonders how many such conventions Mr. Page has attended and in what capacity.

Mr. Page's attempt[8] to prove by Pascal's law, that soft tissue being of high water content is confined and immobilized under a "mucostatic base" and "will immovably support just as much load as hard tissue"—will not bear close scrutiny. His statement[9] that impression taking is "100 per cent a problem in hydrostatics" which "must be majored, if the schools are to have any value in preparing dentistry to solve its problems," reveals his conception to be at loggerheads with dental educators and leaders who are imbued with biologic concepts. This attitude is further exemplified by his flat statement[10] "All restorative dentistry is mechanical."

Mr. Page admits[11] that "no one has yet presented an unqualified answer to the lack of resorption under mucostatic bases," nor, in the opinion of this writer, is anyone likely to come forward with such an answer. He even implies[12] that the retention of a "gum butted" upper denture is as good as that of a denture with complete labial coverage. Pryor[13] has best answered the question, "Why not a mucostatic upper denture?" by saying, "It would ruin any dentist who tried to apply it generally." It would appear that the less said by "mucostatic" enthusiasts regarding upper dentures, the better. Mr. Page ventures[14] into a new field with the thought-provoking observation "that the Gothic arch tracing is a fallacy should be apparent from simple geometry," but does not elaborate on this subject—shades of Professor Gysi!

One is less amazed at Mr. Page's presumptuousness than by the number and prominence of his followers. One of these[15] cites the advertising material of denture adhesives—"that seven out of ten dentures are failures, unless commercial powder is used," to emphasize the deporable status prior to the advent of "mucostatics." Another[16] writes "I am convinced that to keep abreast of scientific pros-

thetics, you must realize that almost all of our present concepts of denture construction are fallacious and cannot be substantiated." It is almost unbelievable that any large percentage of dentists have, in the past, experienced the frustration this statement woud indicate, or that 70 per cent of their patients must resort to the habitual use of adhesive powder. If any of the individual members of the profession have found themselves in such a "slough of despond," perhaps one should not censure them for grasping at straws.

The vigorous exploitation of "Mucostatics" is probably best explained when it is understood that a particular brand of chrome alloy cast into denture bases is strongly recommended as essential to success. The manufacturers and distributors of this metal have assumed a leading role in promulgating the "mucostatic principle." The prophesy is hereby made that less and less will be heard about the "mucostatic principle" as time marches on, and that it will eventually be relegated to the boneyard along with its contemporary, the "restless partial" and its antecedents the "gum butted" and "roofless" upper dentures. The terse comment[17] "This mucostatic gooey is an awful lot of hooey," is strikingly apropos and probably accords the subject all of the dignity to which it is entitled. All that is of value in the "mucostatic principle" is of ancient vintage and only that which is old is good. To paraphrase a currently popular advertising slogan, "nothing new has been added."

REFERENCES

1. Pryor, Walter J.: Physical Forces Utilized in the Retention of Dentures, J. Am. Col. Den. **12**:128, 1945.
2. Addison, Paul I.: Mucostatic Impressions, J.A.D.A. **31**:941, 1944.
3. Page, Harry L.: Mucostatics—A Principle Not a Technique, p. 25, Chicago, 1946, Published by Harry L. Page, 1625 East Washington St., Chicago, Ill.
4. Dykins, W. L.: Page's Mucostatic Impressions, Tic, p. 14, May, 1946.
5. Richardson, J.: Practical Treatise on Mechanical Dentistry, Philadelphia, 1886, Blakiston's.
6. Page, Harry L.: Mucostatics—A Principle Not a Technique, p. 2, 3, Chicago, 1946, Published by Harry L. Page, 1625 East Washington St., Chicago, Ill.
7. Page, Harry L.: Mucostatics—A Principle Not a Technique, p. 3, Chicago, 1946, Published by Harry L. Page, 1625 East Washington St., Chicago, Ill.
8. Page, Harry L.: Mucostatics—A Principle Not a Technique, p. 8, Chicago, 1946, Published by Harry L. Page, 1625 East Washington St., Chicago, Ill.
9. Page, Harry L.: Mucostatics—A Principle Not a Technique, p. 2, Chicago, 1946, Published by Harry L. Page, 1625 East Washington St., Chicago, Ill.
10. Page, Harry L.: Mucostatics—A Principle Not a Technique, p. 2, Chicago, 1946, Published by Harry L. Page, 1625 East Washington St., Chicago, Ill.
11. Page, Harry L.: Mucostatics—A Principle Not a Technique, p. 15, Chicago, 1946, Published by Harry L. Page, 1625 East Washington St., Chicago, Ill.
12. Page, Harry L.: Mucostatics—A Principle Not a Technique, p. 25, Chicago, 1946, Published by Harry L. Page, 1625 East Washington St., Chicago, Ill.
13. Pryor, Walter J.: Physical Forces Utilized in the Retention of Dentures, J. Am. Col. Den. **12**:131, 1945.
14. Page, Harry L.: Mucostatics, a Practical Comparison, Tic, p. 16, April, 1946.
15. Dykins, W. L.: Introduction to Mucostatics, a Principle Not a Technique, p. 1, Chicago, 1946, Published by Harry L. Page, 1625 East Washington St., Chicago, Ill.
16. Draper, Donald H.: Contacts (The Ticonium Co.), p. 941, January, February, March, 1946.
17. Eversull, Hubert: Personal communication.

255 Plaza Bank Bldg.
4711 Central St.,
Kansas City 2, Mo.

A CRITICISM OF THE PRESENT APPROACH TO THE STUDY OF PROSTHETICS

A. O. CHICK, Ph. D., M.D.S.

Prosthetic Department, University of Bristol, Bristol, England.

PROGRESS in the study of any scientific subject follows much the same course. First come the slow years of patient, tedious, and uninspired research; then someone who is luckier or more clear sighted than the rest discovers a truth that throws sudden light into unexpected corners. Those who have been groping in the dark can now see part of their way clearly so that many of them are encouraged and helped in their tasks and achieve their own successes. The tempo quickens. More and more problems are solved and each like part of a puzzle completed helps with the solution of the next. The duration of this stage depends on the importance of the first discovery and of those leading directly from it, but it seldom lasts for very long. Those problems that can be solved are solved and sooner or later progress slows to the original plodding pace.

During the early part of a period in which little or no advance is made, men work on hopefully, always looking ahead. There comes a time, however, when some begin to look back and to wonder if something they have accepted as truth has in fact been false and has led them into a blind alley from which there is no way forward. This questioning of long-accepted doctrine is a healthy sign and has often led in great strides to the better understanding of a subject, and sometimes to its first firm esablishment on a scientific basis.

It seems from a study of the literature that such a spirit of doubt is stirring today in the minds of a few. Craddock and Symmons[1] have looked at the face-bow with critical eyes; Berry[2] has re-examined the temporomandibular joint and has wondered if it really works in the way his teachers said it did.

In these and in others there are signs of a breaking away from the old and hampering habits of mind that have for too long led us to accept as truth anything we have been taught.

That we are, as a body of men, badly addicted to such habits can be shown easily.

Fig. 1 is taken from the March, 1952, issue of this JOURNAL. It shows tracings of the paths said to be followed by various points in the mandible during opening of the mouth. These tracings were given to Clapp by Gysi in 1912, and first published in 1914.[3]

During thirty-nine years, therefore, we have had the opportunity to examine these and to discover the flaws in them. If anyone has done so he does not seem

Received for publication Feb. 2, 1953.

to have published his findings, with the result that nearly forty years later we find them referred to as authoritative in two separate articles in a single issue of this JOURNAL alone (Clapp[4] and McKevitt[5]). It is unnecessary to repeat Gysi's work to find that these tracings are inaccurate. All that need be done is to mark on a piece of tracing paper the starting positions of each point of reference. These are the points marked (*1*). Now the points marked (*2*) are supposed to be the new positions of the points (*1*) after a certain amount of opening. This also applies to the points marked (*3*), (*4*), and (*5*). If, therefore, the tracing paper is moved so that any two of our marks lie above the appropriate points (*2*) we should expect all the others to do likewise. It is immediately found, however, that they do not.

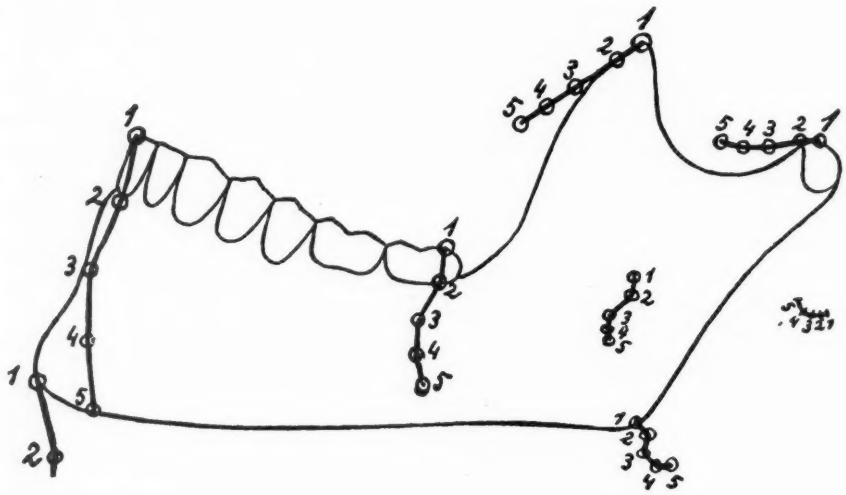


Fig. 1.—Vertical opening movements registered at seven points on the mandible. (J. PROS. DEN. 2:150, 1952.)

A certain degree of error is to be expected in tracings of this nature and, if very small, might not be considered to nullify the results. Here, however, some of the errors are relatively enormous. As an example, if the incisal and symphyseal paths are considered as accurate, we find an error of approximately 4 mm. in the position of condyle point (*2*). This is sufficiently large when compared to the small distance it has moved from (*1*), to render any conclusions drawn from such tracings quite valueless. This is especially the case when the method adopted to reach these conclusions is the erection of perpendiculars on the paths in question (Fig. 2), a method that will produce gross exaggeration of even the smallest of errors.

This example shows the manner in which mistakes can find their way into print and remain unnoticed for scores of years, serving, like false signposts, only to mislead and to confuse. The harmful effect of this would not be great if the mistake appeared only once. Unfortunately, by quotation, reference, and cross-reference, it soon becomes so disseminated throughout the literature that it is to

be found everywhere, and is by no means easily eradicated even after it is recognized.

The example taken is only one of many that can be found, and may in itself be of little importance. In some instances, however, authors begin by taking such mis-statements as a basis upon which to build further arguments. When this occurs, the original mistake becomes father to an increasing number of further errors that may persist long after the correction of the first.

The blame for this state of affairs lies more with us as the readers of our journals than with anyone else. The contributors are human and, as such, not beyond the possibility of error, but the fact that such errors are allowed to pass unchallenged is a grave indictment of our critical faculties.

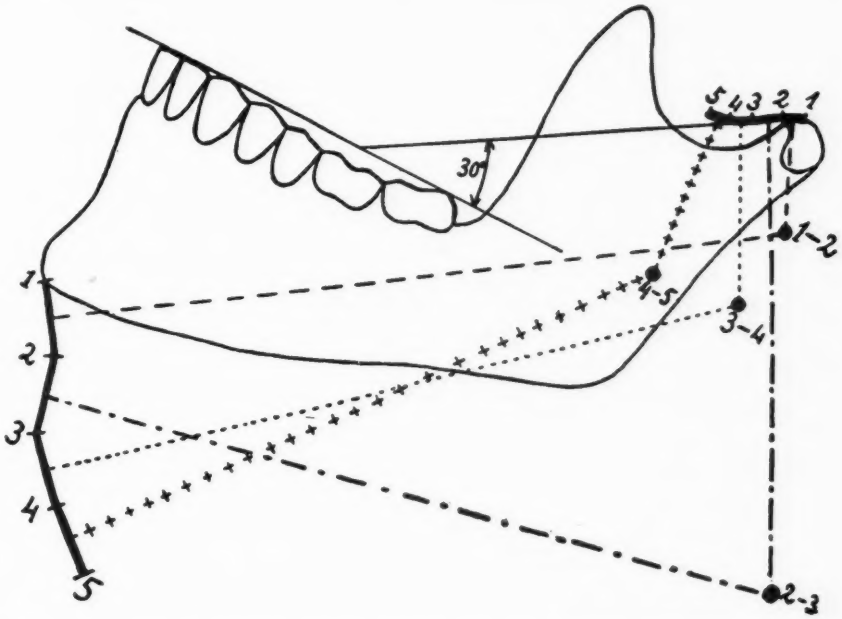


Fig. 2.—The axes of rotation can be located only by drawing radii from similarly numbered sections of two paths so that the radii cross. (J. Pros. Den. 2:151, 1952.)

It may be claimed by some that the mistakes, although unchallenged, are not in fact unnoticed. If this is true, those who have observed them have failed in their duty to their fellows by remaining silent. Whatever has prompted their silence—whether a fear of giving offence, or a feeling of charity—it should not have been allowed to stand in the way of the establishment of truth.

Progress will continue to be slow and fumbling for as long as we retain our old habits of mind. We must cease to read and accept. We must learn to read with skepticism and to question. Where we find mistakes we must fearlessly expose them, and where we are able to confirm we must publish our confirmation.

The publication of a worker in the field of an established science would not be considered seriously for one moment unless he stated clearly how he had achieved

his results, nor would these be accepted until they had been independently confirmed, preferably by more than one person each working independently. When they were so confirmed they would stand as a record of established fact, and other workers would be able to build upon them with confidence.

Our outlook is very different. The great majority of articles on prosthetic dentistry are no more than expressions of opinion without factual backing of any sort, yet they are frequently quoted as authoritative. Those who do aim at the scientific approach often fall far short of what is required from the student of a subject that has achieved the status of a science. If this is doubted we can take

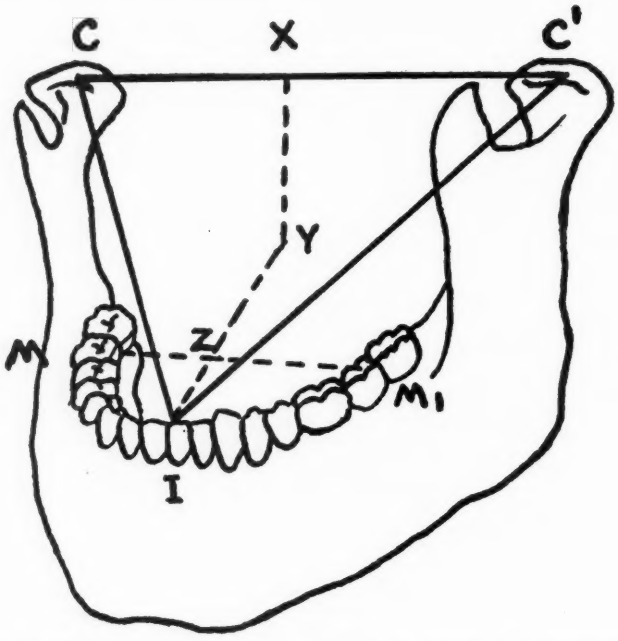


Fig. 3.—Bonwill triangle and points of reference on which the calculations in the text are based. *ICC'*, Bonwill triangle. *IMM'*, Occlusal plane. *IY*, Axis of the parabola of the dental arch; necessarily lies in the occlusal plane. The termination (*Y*) of this line is the point from which a perpendicular to *IY* meets the midpoint (*X*) of the intercondylar axis. *Z*, Intersection of *IY* and *MM'*. By geometrical symmetry. *Z* bisects *MM'*, and *MM'* is perpendicular to *IY*. *I* is the incisor point. *C.* and *C'* are the condyles. *M* and *M'* are the positions of right and left second molars. In the average case, *Z* bisects *IY*. (J. Pros. Den. 2:636, 1952.)

as an example a recent article in the Journal of Prosthetic Dentistry. Let us look at "Evaluation of the Facebow"[1] by Craddock and Symmons. As a critic Craddock cannot be exempted from criticism, and as one with a genuine desire to establish the truth will welcome it. In his article, Craddock gives the results of certain mathematical calculations and clinical experiments, and concludes from these that the use of the face-bow is a waste of time. He may be entirely correct but, until his calculations have been checked and his clinical work repeated, we are in no position to accept his findings. Until then they are of no more value to us than an expression of Craddock's own personal views that may equally be right or wrong.

In spite of this, unless we discard our slavish acceptance of the printed word, we shall probably read in the near future that "Craddock has *proved* that the face-bow is a useless device."

When we try to get away from our easy-going habits, however, and attempt to check upon his work, we meet with difficulty because of his methods of presentation. He says that his mathematical results "can be readily checked by other investigators using the same method." But can they? If a mathematical result is to be readily checked all the necessary information must be given, but Craddock has omitted much of this.

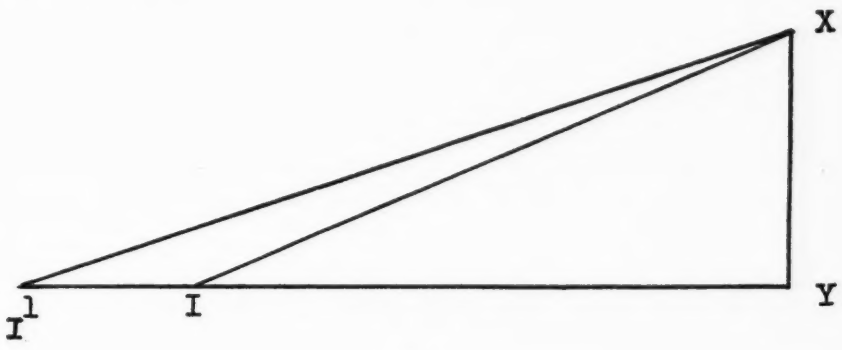


Fig. 4.

INSUFFICIENT INFORMATION

An example of this omission is to be found where Craddock discusses the increase in the length of *IY* produced by an increase in length of the sides of the Bonwill triangle (Fig. 3). To calculate this increase it is necessary to know the size of the angle *XIY*, but no reference is made to this. It is possible to find that Craddock has probably taken approximately 22 degrees as its value in the case of a Bonwill triangle having all sides equal to 10 centimeters.* But detective work of this sort should be unnecessary and can be avoided if the calculations are properly set out.

Other examples are to be found in the section dealing with lateral movements. One of these is an omission to define the distance $M\ M^1$, which must be known before the calculation can be made.

A check would not take long if his calculations were shown, but it is a less simple matter if we have first to discover the methods he used.

UNSUPPORTED STATEMENTS

We now come to another factor that would not be tolerated in a scientific report, namely Craddock's use of unconfirmed data. It has just been said that he appears to have given the angle *XIY* a value of approximately 22 degrees. In a work of this nature, he should not only have stated the fact, but also produced evi-

*See Appendix.

dence to show that this is an acceptable figure. Perhaps the value has been satisfactorily worked out elsewhere but we must not assume that it has. Once again, the point must be clearly made that no calculations involving this angle can be accepted until we are convinced that the value given to it is correct.

Again Craddock says "In the average case Z bisects IY," but produces no evidence in support of this statement. He may well be correct, but the statement must not be accepted as true until it is *proved* to be true.

LOOSENESS OF EXPRESSION

One other criticism can be made, namely, that the expressions used are at times extremely loose. Thus we find "It is obvious that a difference of a few millimeters in the location of an axis which is about 100 mm. distant from the point we are observing can have little practical effect on the arcs generated." (**2**:634, 1952, paragraph 4). The point referred to is I in the diagram, and the distance with which Craddock is dealing when opening movements are considered is IX, which is, in fact, only 86.6 mm. ($\sqrt{10^2 - 5^2}$) for a Bonwill triangle with sides of 10 centimeters.

This and other examples that could be quoted may not greatly affect the ultimate conclusions, but should not occur in an article where calculations are worked out to a thousandth of a millimeter.

AN OPPORTUNITY TO ESTABLISH FACTS

It must not be thought that these criticisms are intended to be entirely destructive. On the contrary, Craddock's contribution must be appreciated highly by all who recognize it as one of the few honest attempts to cut through the dogma that impedes our progress.

Craddock's omissions and unsupported statements are probably deliberate, and prompted by an appreciation of the fact that we have for so many years been too busy or too disinterested to look deeply into work such as this. We can well imagine him debating the publication of his figures and deciding that this was scarcely worth while. But it *is* worth while. In the absence of such evidence one of two things will happen. Either his conclusions, right or wrong, will be accepted thoughtlessly and will do no more than swell the number of unproved statements that encumber the literature, or—which is almost to be preferred—they will be recognized as unproved and, as such, ignored.

The position can be very different if Craddock will give us his data in full. Then we shall be able to confirm or refute his conclusions and make our findings known. This is the way to establish fact.

It may be said that there is insufficient space in our journals for the publication of all the records, measurements, and calculations that form so large a part of research. This is untrue if it is agreed that our aim is the advancement of our study. Each page used towards the establishment of a single uncontrovertable fact is worth dozens filled with unsupported expressions of opinion or with the plagiarisms that so often masquerade as original thought.

Let us, then, ask that contributors give full evidence in support of their statements and clearly show us how they arrive at their conclusions. Let us ask them also to be certain that the work of another investigator is valid before they use it as a basis for their own, or in support of it. If there is doubt on this point, their time would be better spent repeating the work than in building upon it.

But this in itself is not enough. We as readers of the dental journals must probe, question, and criticize if we are to decide what is sound and what is false. When we are able to add to the value of another's work by confirming it, we must say so. When we find an error we must not hesitate to expose it.

In this respect, the JOURNAL OF PROSTHETIC DENTISTRY is in the forefront. The Editor briefly reviews and criticizes each contribution. This is certainly a big step in the right direction, but no one man can make as critical a study of each article as is really necessary. It is even less possible for him to repeat all experimental work. Such tasks can be accomplished, however, if we all play a part. The sooner we begin, the sooner will the study of prosthetics be firmly established on a basis of fact.

APPENDIX

Craddock mentions an increase in the length of CI only. To increase CI and not C^1I would cause I to be moved out of the midline. Craddock does not mention asymmetry in dealing with lateral movements, and asymmetry here would affect his calculations. It is therefore presumed that he has actually considered an equal increase in the lengths of CI, C^1I.

Then, when $CI = C^1I = CC^1 = 10$ cm., $IX = \sqrt{10^2 - 5^2}$ cm.

$$= \sqrt{75} \text{ cm.}$$

Let I^1 be the new position of I when the sides CI, C^1I are increased in length by 2 cm.

Then, when $CI^1 = C^1I^1 = 12$ cm., and $CC^1 = 10$ cm.

$$I^1X = \sqrt{12^2 - 5^2} \text{ cm.} = \sqrt{119} \text{ cm.}$$

(1) $XY^2 + IY^2 = 75$

(2) $XY^2 + (IY + 2.39)^2 = 119$

(2) - (1) gives $4.78IY + 2.39^2 = 119 - 75$

$$IY = \frac{38.29}{4.78} = 8.01$$

$$\text{Cos } \sqrt{XIY} = \frac{8.01}{\sqrt{75}} = \frac{8.01}{8.66} = 0.9249$$

$$\sqrt{XIY} = 22.3 \text{ degrees}$$

REFERENCES

1. Craddock, F. W., and Symmons, H. F.: Evaluation of the Face-Bow, J. PROS. DEN. **2**:633-642, 1952.
2. Berry, D. C.: The Movement of the Meniscus of the Temporomandibular Joint, Lancet **1**:82-83, 1952.
3. Clapp, G. W.: Prosthetic Articulation, New York, 1914, The Dentists Supply Co., p. 145.
4. Clapp, G. W.: There is No Usable Vertical Opening Axis in the Mandible, J. PROS. DEN. **2**:147-159, 1952.
5. McKevitt, F. H.: The Measured Vertical Dimension and the Plane of Occlusion—Lost Coordinates of the Bennett Movement, J. PROS. DEN. **2**:182-187, 1952.

UNIVERSITY OF BRISTOL DENTAL SCHOOL
LOWER MAUDLIN STREET
BRISTOL 1, ENGLAND.

REPLY TO A. O. CHICK

F. W. Craddock, B.A., Dip.Ed., D.D.S.(N.Z.),
M.S.D. (Northwestern),* and
H. F. Symmons, B.Sc. (Hons.), Grad. I.E.E.**

University of Otago Dental School, Dunedin, New Zealand.

WE AGREE entirely with the spirit of Mr. Chick's article, and are heartened by the evidence which it provides that articles on prosthetic dentistry are being read critically. In the course of answering his objections we shall repair the few omissions from our original article and thus enable him to repeat our experiments and scrutinize our initial assumptions more closely.

We look forward with genuine interest to learning in due course whether or not his results differ significantly from ours, and especially whether they are so much at variance as to warrant an entirely different conclusion as to the practical utility of the face-bow from the one which we reached.

We believe that Mr. Chick is mistaken in thinking that if the whole of a mathematical analysis is given in full (as in his Appendix) the work can then be more easily checked for error, or that to do so is either customary or desirable in scientific articles. Errors in mathematical analysis are of two types: the arithmetical slip, and the error in method. The detection of both is often made easier by a completely new start from the original data. Line-by-line guidance of the reader's thought may lead him unwittingly into the author's mistake, if any. In dental writing, we think that a useful distinction can be made between the form of reporting suitable for a thesis on the one hand, and for popular consumption in periodical journals on the other. The sight of even a few mathematical equations is often sufficient to make the average dental practitioner (whom we were trying to reach) shun the article in favor of something easier but of less consequence. The exceptional practitioner or the dental research worker who understands mathematical techniques is, as can be inferred from Mr. Chick's article and confirmed from his Appendix, quite capable of looking after himself.

We agree, however, that it is the author's duty to insure that all primary assumptions are clearly presented to the reader so that he may decide whether the attack on the problem has been soundly based and so that he may, from the same starting point, proceed with his own independent analysis. In failing to define the angle XIY, we were guilty of leaving out a dimension of importance to anyone wishing to check our analysis. The omission can be attributed to the fact that we did not explicitly use this angle at any time. There are, of course, many methods of defining the solid geometry of an object of the kind depicted in our Fig. 2. Since angles are difficult to measure we chose instead certain well-known or easily ascertainable perpendicular dimensions. But we should have stated that the dimension IY is taken as 8 cm. (which is implicitly equivalent to giving the size of the angle XIY), and that the dimension MM' is taken as 5 centimeter. The reasonableness of these values for the purpose we had in mind can be checked readily by anyone with access to a ruler, set-square, and skull, as is the statement that "In the average case Z bisects IY."

Mr. Chick is also correct in pointing out our failure to mention that the problem was regarded as a symmetrical one, so that an increase in the length CI of the Bonwill triangle, implied an equal increase in the length $C'I$. But when he chides us for saying "about 100 mm." when,

Received for publication Feb. 18, 1953.
*Associate Professor of Prosthetic Dentistry.
**Lecturer in Physics.

in the example chosen, the exact dimension is 86.6 mm. we think that he is splitting hairs. The fact that some of our "calculations are worked out to a thousandth of a millimeter" has no bearing on the 100 mm. approximation, and in itself carries no implication of great accuracy. The accuracy of a measure depends, of course, on how big is the length that is quoted to a thousandth of a millimeter. If the total length were two-thousandths of a millimeter then, in a measurement to a thousandth of a millimeter, the implied accuracy is only 50 per cent; but if the length were 10.0000 cm., then the implied accuracy is 0.001 per cent. It is true, however, that our figure 0.107, which implies an accuracy of 1 per cent for one of our dimensions, would have been better expressed as 0.11. But again we do not think that any of the magnitudes which we assigned to our measurements are so inaccurate as to "fall far short of what is required . . . of a science" or seriously to mislead any reader as to the sort of result that a face-bow achieves.

If Mr. Chick can show that either our anatomic assumptions or our calculations, or both, are highly inaccurate, then our conclusions may be disproved effectively. But if the prosthetic errors which follow from failure to use a face-bow have anything approximating the small order of magnitude which we have found, our conclusions must stand and Mr. Chick's suspended judgment must give way to acceptance.

We should like to take this opportunity of pointing out a misprint on p. 642 of the original article. In line 16 the figure 0.017 should read 0.107.

P.O. Box 647,
Dunedin,
New Zealand.

AN IMPROVED IMPRESSION TECHNIQUE FOR PARTIAL DENTURES WITH DISTAL EXTENSION SADDLES

EMIL H. BOLLWERK, D.D.S.†

St. Louis, Mo.

PARTIAL DENTURES and removable restorations have often been facetiously referred to as orthodontic appliances, or a delayed-action method for extracting teeth. Some have gone so far as to say that one by one the supporting structures of the abutment teeth become atrophied by the pressure or trauma created by muscle tension exerted on the overextended peripheries of the distal extension type of denture. So, why not make an immediate full denture and save the patient the time, aggravation, and expense of such a partial replacement.

It is not necessarily the failure of the design of the denture or the clasping teeth that destroys the structures supporting the natural teeth, but rather, it is the lack of provision in impression making for the recording of the soft tissues of the saddle area in the proper relation to the remaining natural teeth, the abutment teeth and the muscle attachments. In short, the muscle pull destroys the supporting structures.

THE TRAY

It is assumed that all periodontal involvement has been corrected and that the stress-bearing areas have been prepared on the abutment teeth and/or other teeth. An impression of the entire arch is made in either an alginate or reversible hydrocolloid material and poured in stone. A clear acrylic tray is formed over this cast. The tray is fitted to the denture base area, and the borders are trimmed in the same manner as for a full denture impression. They are trimmed two millimeters short of the reflection on the buccal, and enough on the lingual to prevent the tray from lifting when the tongue is fully extended out of the mouth.

The outline form of the denture base area is trimmed with Kerr green-stick modeling compound to include the retromolar pad, the M or masseter plane, and the B curve or buccal pouch. The lingual roll is developed by the proper tongue movements, that is, by the extension of the tongue straight forward and then into the opposite cheek. This movement is the same as to remove food from the buccal pouch. When a satisfactory peripheral outline has been developed on both sides, and in the anterior lingual area, some of the compound is trimmed from the area of the lingual frenum, so no pressure is created on Wharton's duct. This area will be recorded in a zinc oxide-eugenol wash impression.

The occlusion rim is built up on the saddle area of the acrylic tray. The occlusal surfaces of the occlusion rim are softened, and the stock tray to be used in the final impression is placed over this to apply pressure on the softened surface. The occlusion rim should be built high enough so that when pressure is exerted in making the final impression, the pressure of the tray will be referred

Received for publication on April 20, 1953.

†Deceased.

to the occlusion rim and not to the incisal edges of the anterior teeth, because the final impression is to be made with a slight pressure on the saddle area only.

To facilitate the removal of both impressions in one piece horizontal grooves are cut in the occlusion rim on the lingual and the buccal sides to create a mechanical lock between the two materials.

After the trays and the occlusion rim have been developed, the handle of the acrylic tray is cut off, and enough acrylic is cut away to expose fully the lingual surfaces of all of the teeth.

THE FINAL IMPRESSION

An impression of the tissue bearing area is made in a zinc oxide-eugenol impression material. The mouth is dried with sponges prior to making this impression to prevent defects caused by saliva. After this impression has set, the impression material is removed from the interdental spaces and the lingual surfaces of the teeth without removing the impression from the mouth. A water jacketed tray filled with reversible hydrocolloid is placed over the occlusion rim, tray and zinc oxide-eugenol impression. Pressure is exerted by this stock tray against the occlusion rim. The amount of pressure is determined by the type of soft tissue on the ridge area. The hydrocolloid impression material is chilled by water at 60° F. After five minutes the hydrocolloid material will be set and both impressions are removed from the mouth in one piece.

The impression procedure for a precision attachment denture is somewhat different. Two impressions are made in the reversible hydrocolloid material in a water jacketed tray. Vacuum mixed stone is vibrated into the prepared abutment areas of one of the impressions to form the individual stone dies. The second impression is poured immediately in stone to form the master cast.

Either three-quarter or full crowns are waxed on the master cast. The precision attachments are waxed into position, using a paralleling device. The gingival margins of the wax patterns are corrected on the individual dies and cast in gold.

The finished castings are placed on the master cast, and this is duplicated with the castings in place, and poured in stone. On the duplicated cast, an acrylic tray is waxed and processed. This tray is fitted and trimmed to fit the original cast—not the duplicated cast.

The gold abutments are fitted back on the teeth in the mouth, and the acrylic tray is fitted to the denture base area. The tray is trimmed the same for a partial denture with clasps.

The remainder of the procedure is essentially the same as for a partial denture with clasps except the final impression is made in plaster, and with the gold castings in place on the natural teeth. Both impressions are removed from the mouth and reassembled. The gold castings and zinc oxide-eugenol impression and reassembled. The gold castings and zinc oxide-eugenol impression and the plaster impression are assembled in the tray, and poured with a vacuum mixed stone. Tincture of green stone is used for a separating medium.

This combination impression will produce an accurate impression of the soft tissues, the ridge areas, and the teeth in their proper relation to one another for maximum function, and for the minimum of traumatism of the supporting structures of the abutment teeth.

A THEORETIC METHOD OF OCCLUSAL CORRECTION

A Theory of Principles for and Their Application in a Technique for Correction by Grinding of Disharmonies in Functional Occlusion of The Human Dentition.

Thomas D. Gilson, D.D.S.

Ann Arbor, Mich.

THE FOLLOWING discussion embodies principles employed by the writer in his practice for more than five years, in the attempted correction by grinding of occlusal disharmonies that occur during function, to help control the processes of periodontal disease. The method presented is the outgrowth of the author's trial and error methods for seven years prior to this relative standardization.* The technique has been evaluated solely on the results of its clinical application.

There is always a strong tendency on the part of an observer to "read in" more favorable patient-responses than actually occur in any purely clinical undertaking of correction and observation; however, the results of five years of attempting the correction with this approach have been gratifying enough to suggest bringing the method before other workers for their consideration.

The results were appraised by observing certain factors before, and noting favorable changes in them, during, and after the occlusion was corrected. These factors were: (1) color, form, and density of the gingivae, and depth of the gingival crevice; (2) tooth mobility; (3) rate of accumulation, relative amount, and character of the subgingival deposit; (4) relative pulpal irritability of the teeth. The time necessary to "finish the correction" has been found to vary greatly, from patient to patient.

For purposes of brevity and simplicity, considerations will be based on Angle's Class I type of tooth arrangement; i.e., the conventionally accepted normal, or ideal, relationship of jaws and teeth. The same principles hold true, perhaps in a somewhat less idealistic fashion, for other arrangements of teeth, but these will not be considered here.

Reference will be made to certain so-called artificial "positions" and "movements" or "excursions" and these will be defined and explained. It must be assumed that the teeth are in contact in all instances: positions, movements, or

Received for publication Jan. 31, 1953.

*The writer is deeply indebted to these men, whose contributions, in revealing their experiences and procedures in this subject to him through the years, made it possible for the formulation of this theoretic method: L. C. Schultz, Russel Vietor, Leon Hickok, Steven Brown, E. Romle Romine, D. A. Kerr, Edgar James, R. A. Roeser, Charles H. M. Williams, C. Mark Gilson.

excursions. The author believes that these artificial, deliberate movements are only a guide for the operator in the correction. While the patient goes through *similar* movements in reflex function, other factors enter into the way the jaw then moves, and the excursions are in many ways different from these deliberate movements.

The operator's success or failure depends largely on his ability to educate the patient to assume deliberately these artificial positions and to make these artifical movements deliberately during the process of the correction. The wide variation in the adaptability of individual patients to this procedure must be kept in mind, and the degree of difficulty anticipated with each patient had best be determined during the diagnosing session with the patient before the correction is attempted. Many patients are seen repeatedly for sessions of grinding over a period of as long as a year before they are able to produce completely satisfactory excursions and reach certain jaw positions perfectly while in the chair.

POSITIONS AND MOVEMENTS DEFINED AND EXPLAINED

I. *Centric Position.*—

Definition: The relaxed closed position of the jaws, with teeth in interdigitated contact.*

1. All teeth (ideally) will be found to be in contact in this position, although in some cases of extreme disharmony some periodontally involved teeth may have had to move in order for them all to do so.

2. All teeth will invariably seek an opponent in this position unless some mechanical force prevents their doing so.

3. The patient will usually reach this position easily if seated upright and asked to close the jaws instantly after swallowing.

II. *Retrocentric Position (and Movement).*—

Definition: The most extremely retruded position in which the mandible can be placed with some opposing teeth contacting.

1. This position is a highly artificial one and is never (or very rarely) reached by the patient naturally. He must be educated to reach it with the aid of methods later to be described or by the application of a "retruder."

2. While the retrocentric movement (that is, the excursion of the mandible from centric back to it and vice versa) is achieved by the patient in function with only one joint at a time, this bilateral artificial movement, artificially carried out in a manner described later, greatly facilitates the correction of interference in the unilateral functional movement.

3. The importance of interference in this particular movement cannot be overemphasized, since it is the most, or certainly one of the most, destructive of all interferences.

4. There is wide range of variation among patients in this position and movement. In some patients the centric and the retrocentric positions are one and

*This position has been named "Acquired Centric" or "Centric Occlusion of the Teeth" by other observers.

the same, and the movement is practically nonexistent (very rare). In others the movement is very long. In some people, there is a long retrusive movement on the part of one joint and little if any in the other joint; so that when they give the movement from centric position back to retrocentric position and vice versa the excursion appears almost as a sidewise motion.

5. Suitable notations of such peculiarities and interferences encountered in the excursion should be charted during the diagnosing session.

III. *Lateral Movements.*—

Definition: The moving of the mandible laterally from the centric position and vice versa, either to right or left, with teeth in contact.

1. A wide range of possibilities exists in these movements. Patients before equilibration often subconsciously "protect" certain interfering teeth by "going around" them during these excursions when directed to do so deliberately. They do this by combining the lateral movement with the protrusive movement.

2. The most direct lateral movement can often be achieved by asking the patient to move the chin directly toward the shoulder.

3. Suitable notations of peculiarities and interferences (which cusps are holding, tooth movement, etc.) should be made at the diagnosing session.

IV. *The Protrusive Movement.*—

Definition: The moving of the mandible directly anteriorly from the centric position and vice versa, with the teeth in contact.

1. Again some patients, before equilibration, will subconsciously "protect" certain interfering teeth by "going around" them by combining the lateral movement to some degree in combination with this protrusive movement.

2. Suitable notations of occurrences during this excursion should be made during the diagnosing session.

AIMS IN THE CORRECTION

It is the writer's belief that most of the damage done from functional occlusal disharmony is done within a relatively limited range (roughly two millimeters) away from what is called herein the "centric position." There are the exceptions of bruxism and/or bruxomania to this rule. In such instances more radical corrections should be attempted; however, the "two-millimeter-rule" is a convenient yardstick for the correction procedure. In other words, all teeth are placed in function for two millimeters in each lateral excursion and for two millimeters in the protrusive excursion. Correction to this standard usually can be accomplished without changing the outward appearance of the teeth.

The following ends are desirable in the correction, and their achievement is attempted in this order: (1) retrocentric balance, (2) two-millimeter lateral

Note: For lack of more suitable terminology and since, in the main, every dentist is familiar with the "Complete Denture" nomenclature of occlusion, the terms "working" side, movement, and planes, and "balancing" side, movement, and planes will be used without definition.

balance to the right, (3) two-millimeter lateral balance to the left, (4) two-millimeter protrusive balance, (5) even distribution of forces in wide lateral and protrusive excursions exceeding the "two-millimeter-balance" range.

1. *Retrocentric balance* or balance in the retrocentric movement means:

(a) This artificial, bilateral movement from the centric position back to the retrocentric position and vice versa should be produced in and/or by the patient without any appreciable opening of the jaws.

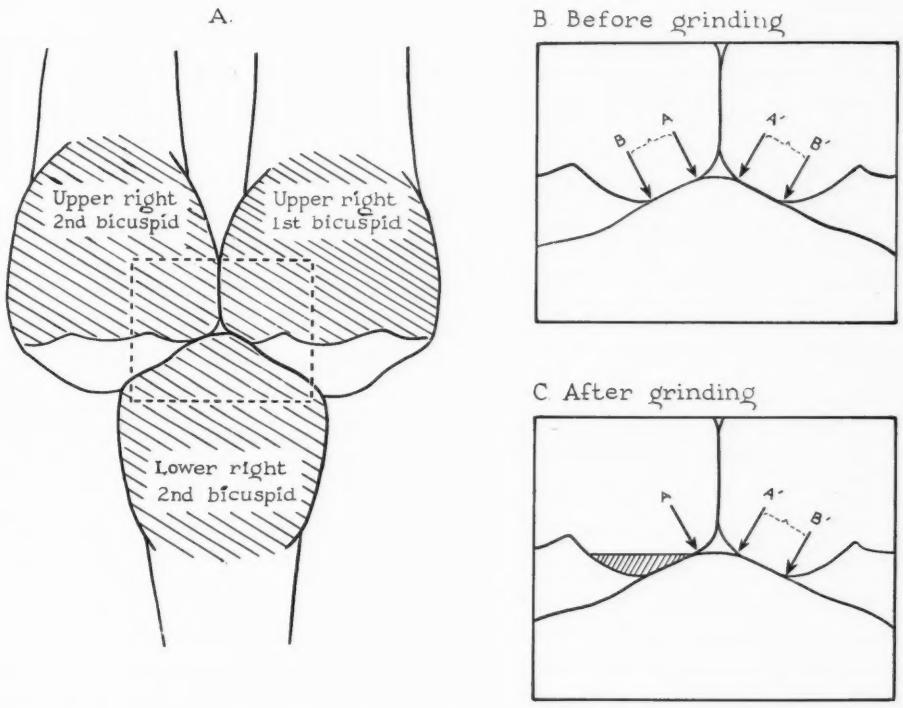


Fig. 1.—*A*, A lower bicuspid seating on the marginal ridges of upper bicuspids in the centric position. *B*, An enlargement of the centric bearing planes *B-A*, *A'-B'*. *C*, The retrocentric correction of plane *B-A* on the marginal ridge of the second bicuspid with only A end of the plane left in contact in centric position, with the retrocentric balance correction completed.

(b) As many as possible (all, ideally) of the posterior teeth should be in even contact during this movement, eliciting from the patient a comment on feeling this sensation as well as feeling the sensation of "evenness" and "flatness" as the movement is made.

(c) It will be found before correction that the patient will have plane-to-plane centric contacts. The angulation of these planes may be altered in a manner such that a line or even point-to-plane contact can be left to hold the centric position, still allowing for the creation of the retrocentric balance. See Fig. 1 and explanation.

(d) Repeating, these centric points of the supporting cusp traverse these corrected planes only on one side at a time during function; however, the ease with which interference can best be detected and eliminated safely in this very important movement justifies the use of this artificially-produced retrocentric movement, and achievement of "retrocentric balance."*

2. *"Two-millimeter lateral balance to the right"* means: All teeth (ideally) are in even contact during an excursion of the mandible in the direct right lateral movement, either to or from the centric position for a distance of two millimeters (measured roughly by the eye of the operator in the first bicuspid region).

3. *"Two-millimeter lateral balance to the left"* means: All teeth (ideally) are in even contact during an excursion of the mandible in the direct left lateral movement, either to or from the centric position for a distance of two millimeters (measured roughly by the eye of the operator in the first bicuspid region).

4. *"Two-millimeter protrusive balance"* means: All teeth (ideally) are in even contact during an excursion of the mandible in the direct protrusive movement either to or from the centric position for a distance of two millimeters (measured roughly by the eye of the operator in the central-incisor region).

5. *"Even distribution of forces in wide lateral and protrusive excursions exceeding the "two-millimeter balance range"* means: As many supporting-cusps riding guiding inclines on the side toward which the mandible is laterally moved should be placed in contact in as wide an excursion as possible without excessively shortening the teeth or unduly denuding the planes of enamel. Likewise as many guiding inclines on the lingual surfaces of the upper incisors should be put to work against supporting incisal *edges* ("edges" not "planes") as can be done conveniently without excessive shortening of the teeth or undue denuding the planes of enamel.†

6. In a sense, the crux of this whole theoretic concept is the attempt to create a range of functional freedom around this centric position. Civilized peoples apparently do not have sufficient abrasive materials in their diets to do this for themselves. Usually in this centric position their teeth lock tightly. There is terrific disharmony in the manner that the teeth meet and function as soon as the mandible is moved even slightly in any direction from the centric position. To change angulations of planes around the centric position for a limited range, so the teeth can be used with the full power of the musculature at work without certain individual teeth being moved excessively in their sockets, is the desired end to the correctional procedures.‡

---

*After the correction, retrocentric position becomes what is called by other observers: "true centric" or "centric relation". In other words "centric occlusion" of the teeth has been corrected to accommodate the "centric relation" of the jaw and skull.

†*Note:* In *all instances* the preservation of the contacts in the position that has been described here as the "centric position" is of paramount importance and requires no small amount of thought and skill.

‡*Note:* The author theorizes that anywhere in this 2mm. range of balance created in retrocentric, lateral, and protrusive movements, the patient's jaw is capable of a "hinge-axis" closure without teeth interfering. If tooth interference does exist, it is (ideally) distributed throughout all the teeth simultaneously and as such on planes of compatible angulation. This renders such interference tolerable by the supporting structures.

PROCEDURES OF THE CORRECTION

The procedures will be taken up in the order that the author has found to be most advantageous: I, Retrocentric Correction; II, Centric Correction; III, Lateral Correction; IV, Protrusive Correction; V, Functional-Chew-in Correction and Final Testing.

Each of these separate correctional procedures will be discussed in this sequence: A, Patient Education; B, Marking Interferences; C, Evaluating the Markings; D, Eliminating Interference; and E, Patient's Response.

I. *First Procedure: Retrocentric Correction.*—

A. *Educating the patient:*

The patient is first educated to produce the movement from retrocentric position to the centric position, and later vice versa.

1. The patient is tipped back in the chair and his head arranged so that gravity will help in retruding the mandible.

2. He is asked to relax the jaws so that the operator can grasp the chin gently with thumb and forefinger and easily open and close the mandible at will.

3. He is asked to curl his tongue up and back down the throat as far as he can.

4. The operator then gently presses the jaw closed on its hinge axis until the teeth just feather-touch each other. (Interference is *felt* by the patient starting here.)

5. The patient is asked to close hard and bring all the teeth into contact. (The glide into the centric position down the interfering retrocentric guiding planes will be experienced by the patient and can be seen easily by the operator.)

6. This process is repeated several times until the patient is able to produce this movement with a reasonable assurance that the insertion of articulating paper for marking purposes will not confuse him.

B. *Marking the interfering cusps and planes and interpreting the marks:*

1. The foregoing manipulation is repeated with articulating paper in both sides of the mouth over the bicuspids and molars.

2. Usually (not always) interference will be found to be on the mesiobuccal inclines of palatal cusps of upper teeth against distolingual inclines of buccal cusps of lower teeth, and markings will be so located.

3. The study casts, articulated in their centric position, are then consulted. Decisions are made (if there is a choice, and there often is) as to which planes of which cusps in which fossae will be the centric supports, and will be the guiding inclines in each instance. Suitable notations, of these decisions are made.

C. *Interpreting the markings (Which end of the mark is the centric and which is the retrocentric plane to be relieved?):*

1. If the supporting cusp is a buccal cusp of a lower biscuspid, as in Fig. 1, and the retrocentric interfering plane is on the mesiobuccal aspect of the palatal cusp of the upper bicuspid, the end of the interference, or the centric line, will be the mesiobuccal end of the mark on the upper bicuspid. (See Fig. 1, *C*, point *A*.)

2. The point where the buccal cusp of the lower bicuspid contacts the mesial marginal ridge of the upper bicuspid (point *A*) is the centric (cusp to bearing-point) area. This will be the last speck of the mark made in the excursion from

retrocentric position to centric position. If the teeth are taken out of contact by indiscriminate stoning at this point, the centric contact is lost, and tooth eruption will take place. Eruption will take place unless eccentric function prevents its doing so; in which case serious periodontal difficulties will be produced.

3. The shaded area indicates the portion of the upper bicuspid that is stoned away to relieve the retrocentric interference. Excuse must be made here for the inadequacies of a two-dimensional drawing. In addition, the stoning is done palatally and distally into the palatal cusp of the upper bicuspid on its mesiobuccal aspect, too (Fig. 2).

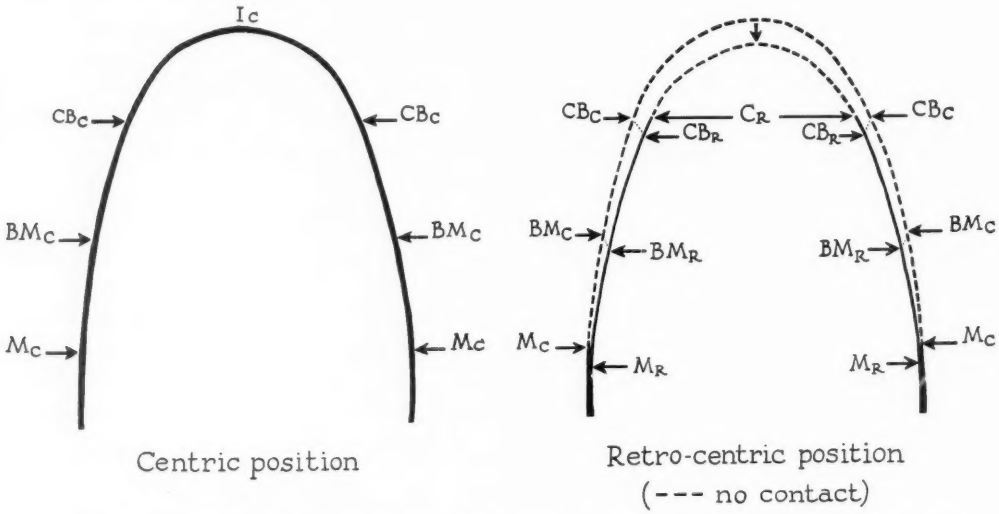


Fig. 2.—*Left,* Arch labeled *Ic* represents an occlusal view of the centric points on both upper and lower jaw in the centric position schematically. *Right,* Arch labeled *Cr* indicates the centric points on the lower jaw in the retrocentric position.

Note points *CBc* and *CBr,* points in the arches roughly representing the lower first bicuspid buccal cusp as in Fig. 1. Note that the point *CB* moves distally *and palatally* in a retrusion from centric into the retrocentric position. Likewise points *BMc* and *BMr,* points roughly in the first molar region. Here the palatal movement is somewhat less, but still definite.

This drawing represents a patient's retrocentric jaw movement with both joints retruding in an equal fashion. If the movement is otherwise, suitable approaches must be made.

D. *Eliminating the Interference:*

1. The retrocentric interfering guiding planes are then stoned away, with care to preserve the centric end of the mark in each case.

2. This procedure is repeated, i.e., the patient produces another retrocentric to centric excursion with marking paper in place, and the interfering planes (each time they will be less steep) are stoned again, care being exercised to preserve the centric ends of the mark. The procedure is repeated, until the patient is able to move back and forward from centric to retrocentric and vice versa with ease and with the feeling that there are no "high spots" or "hills" in his way and that many teeth are in contact during that movement.

3. *Summarizing:* theoretically, at this point all the centric bearing points have been preserved on all the teeth. The end that has been accomplished is: retrocentric guiding planes have been altered in such a way that the mandible is now able to move from the centric position back to the retrocentric position without appreciable opening, and the bearing cusps of the posterior teeth are all (ideally) working evenly on these planes in this unnatural movement.

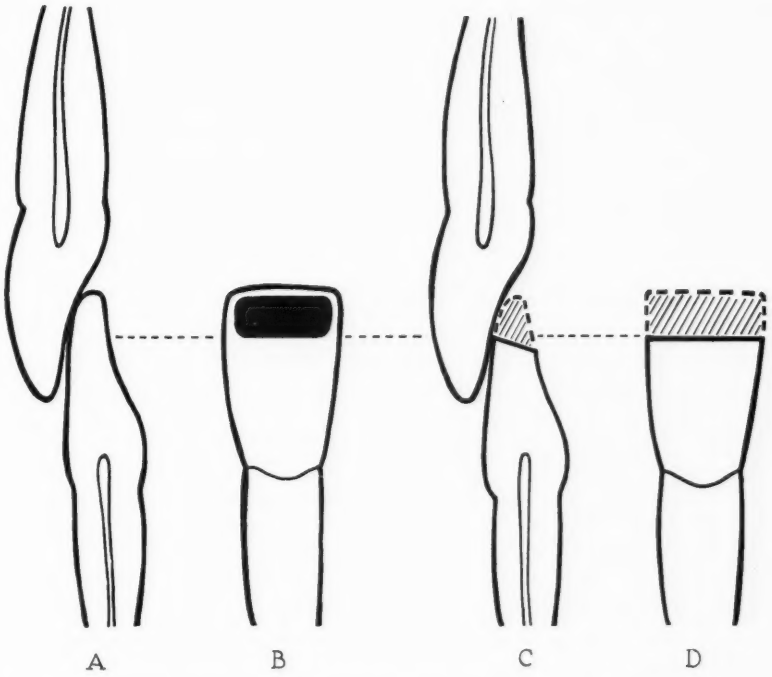


Fig. 3.—*A,* Proximal view of the plane-to-plane centric contact between anterior teeth. *B,* Labial view of a lower incisor marked after centric tapping on articulating paper. *C,* Proximal view of the corrected centric contact with the lower incisor shortened. *D,* Labial view of the corrected centric contact with the lower incisor shortened.

E. *Patient's Reaction:* The patient is educated by this time to the point where he is conscious of what is being attempted, and in the last analysis, his feeling of what is happening in the excursion is the best guide the operator has. Usually the patient can indicate the last little bits of interference and where they are occurring (one or the other of the teeth where the interference is still heavy) with the index finger. He is asked to touch the tooth that he feels as a "prominent point" as he makes the movement and invariably he can indicate it accurately.

This is checked with the marking paper as before, and the offending plane is altered by stoning as before, until the patient feels an eveness throughout the excursion.

II. *Second Procedure: Centric Correction.—*

A. *Educating the patient:* The patient is first educated to produce this position.

1. He is asked to sit upright and close the jaws instantly after swallowing.

2. He is reminded that all teeth (including the anteriors) are touching in this position. He is directed to "tap" the teeth together (by alternate slight openings and closings of the jaws in a light tapping movement) when he has located such a position.

3. Some time should be spent with the patient at this point so the operator is sure the patient can close in this centric position time and again without "sliding back" into some measure of retrocentric movement. (The latter commonly happens because interference in that movement is now gone and the mandible can retrude easily in that direction.) However, if this happens, only posterior teeth will be in contact. The patient must feel the anterior teeth at the same time to be in the centric position.

B. *Marking interference* is postponed here until the interference is located in one of two methods:

1. The patient "taps" in the centric position using successively lighter taps until the teeth are just "feather-touching." He is then asked to touch the early-contacting tooth he "hears" or "feels" while he is tapping with his index finger. His judgment is the best guide in correcting any interference in this position. Then marking paper is used to locate the offending area on the tooth that the patient indicates.

2. In advanced cases of periodontal disease, where tooth mobility is excessive, the operator can best be the judge early in this correction by sighting along a row of cusps or labial surfaces and watching the teeth for early movement before the complete closure is reached and then proceeding to mark the offending points.

C. *Eliminating the interference:*

1. Posterior Centric Correction. (a) To repeat, the hazard of the patient's jaw retruding behind the centric position must be regarded as a possibility at all times. So in the stoning of an interference marking in this position, it is assumed that this retrusion has happened.

(b) This then calls for leaving the end of the mark in the manner that was suggested in the previous correction procedure (retrocentric correction) (part *C*, No. 3.). In other words, the interference is treated as if it were a retrocentric interference and stoned accordingly, leaving the last point of the mesiobuccal end of the mark on upper planes and the last point of the distolingual end of the mark on the lower planes.*

(c) This "tapping, marking, and stoning" is repeated until instantaneous contact of all teeth is felt.

2. Incisor Centric Correction. (a) Reference was made in the foregoing "aims of correction" that the incisal centric should be an "edge-to-plane" contact; the incisal edges of the lower teeth should be in contact with the guiding-planes on the palatal surface of the upper incisors.

***Note:* The foregoing only applies to "tight" teeth. In very mobile teeth, the whole mark must (many times) obviously be stoned to minimize the tooth movement and distribute the centric position forces throughout all the members in an even fashion.**

(b) Usually, before correction this relationship will be such that a plane of varying size will be found on the lower incisors instead of an edge, thus producing a centric plane-to-plane contact between the upper and lower teeth (see Fig. 3, *A* and *B*).

(c) Making sure that the patient is not in some slight *protrusion* and is making a tapping movement only in the centric position, new articulating paper markings are made in the incisor region (see Fig. 3, *B*). The mark will so indicate the plane on the lower incisors.

(d) By reducing the length of the lower incisors with a stone down to but still leaving the last bit of the mark (along a mesiodistal line, Fig. 3, *D*), the plane-to-plane contact is converted to an edge-to-plane contact (Fig. 3, *C* and *D*).

D. *Patient's Response as Final Guide:*

1. The patient feels the instantaneous contact of all teeth in the *lightest,* feather-like tapping.

2. The sound to the operator, when tapping is done, is as sharp and *clean* as a hammer blow.

III. *Third Procedure: Lateral Excursion Correction.—*

A. *Educating the Patient:*

1. The patient is educated to produce the movement from the centric position to the lateral position and vice versa. Care should be exercised to prevent the patient from making a subconscious "tooth protecting" movement as described in "Positions and movements defined and explained," Part III.

2. The trick of asking for a "direct movement toward the shoulder" has proved useful. Also, the suggestions of "going right on up the hill" or "forcing on up over whatever is in the way" sometimes help to induce the proper movement.

3. Notations of what is going on during this excursion are made, with reference to these factors: (a) tooth movement (sighting along the rows of cusps); (b) how far does the jaw move before which tooth (teeth) bear(s) the entire load? Is there any "balance-range?"; (c) is the inclination of guiding inclines such that by alteration others can be utilized to advantage?; (d) is the vertical overlap such that the "two-millimeter rule" must be further restricted perhaps to a "one-millimeter rule" to prevent excessive mutilation of tooth structure?

B. *Marking Interference:* When the operator is convinced that the patient can produce a correct lateral excursion, articulating paper is inserted bilaterally and the markings for the excursion are registered.

C. *Evaluating the Markings:*

1. By this time, having worked out and eliminated the retrocentric interferences and having corrected the centric occlusion, the operator is familiar with the centric cusp-to-bearing point relationship in all instances around the arches.

2. It will be found that these centric areas are included in the markings just registered. These marks of the lateral excursion will usually be found thus: (a) Supporting cusps will be buccal aspects of buccal cusps of lower teeth working against guiding inclines on the palatal aspect of buccal cusps of upper teeth. (b)

Also supporting cusps will be palatal aspects of palatal cusps of upper teeth working against guiding inclines on the buccal aspects of lingual cusps on lower teeth. (See Fig. 4.)

D. *Eliminating the Interference:*

1. The stoning to be done in the correction to put all the teeth in function for the "two-millimeter" range is on the shaded portions of the cusps, at all times preserving the "line-to-line" centric contacts. (See Fig. 4.)

2. The marking and stoning are repeated until an even distribution of force is being delivered throughout the mouth with the minimum destruction of cuspal

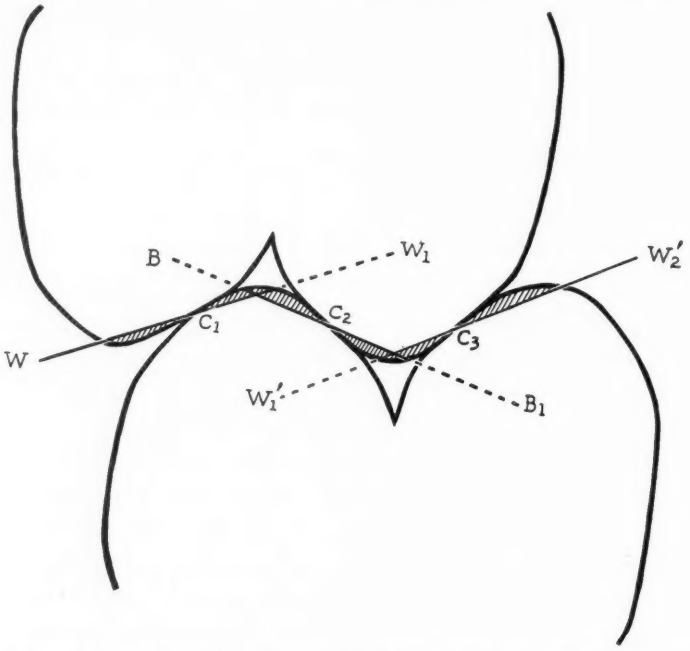


Fig. 4.—This schematic drawing represents a buccolingual section through posterior teeth in contact in the centric position. Points of centric support are labeled *C1, C2, C3.* The lines *W-W1* and *W1'* — *W2'* indicate the working excursion. The line *B-B1* is the balance excursion.

The shaded portions of the cusps indicate where grinding may be done without taking the teeth "out of centric" in the correction of the lateral excursions, providing that the last little bits of the marks at positions *C1, C2, C3* are left to hold the centric contact. *Caution*: Minimum cuspal change is ideal, and nothing is to be gained by mass reduction in the manner and to the extent that this drawing indicates.

form and shape. It should be emphasized that mutilation is to be avoided. Nothing is gained and trouble is invited by attempts to lower cuspal inclinations beyond what is necessary to get all (ideally) the teeth in function. While cross bites and other bizarre arrangements of teeth and jaws sometimes call for radical procedures, minimum alteration in tooth form should always be the rule.

E. *Patient's Response:*

1. During the lateral excursions correction, the patient's feeling of what is happening is not as accurate a guide as in the other corrections. Because of the

many possibilities of combining the protrusive and lateral movement in a protecting fashion, the patient may "feel good" yet still need further correction.

2. However, if he is directed to move his jaw first in one direction then back to and through centric and to the other direction, i.e., moving first to one side and then the other repeatedly for a dozen or so excursions within the two-millimeter range, with alternate heavy unilateral muscle pull, and if he makes the comment that all teeth feel "even, smooth," and that "they all are working," the desired end is reached up to this point.

Fig. 5

Fig. 5.—This schematic representation illustrates a section through anterior teeth in centric position after the incisal centric correction. The shaded portion of the upper incisor indicates area to be relieved to gain not only the lateral correction, but also the protrusive correction, still maintaining the centric contact.

IV. *Fourth Procedure: Protrusive Correction.*—

A. *Patient Education:*

1. The patient generally can make the protrusive movement rather easily when asked to "slide out on the front teeth" or "move as if to bite off a thread."

2. Care should be exercised to see that he is not "protecting" some interfering teeth by combining the protrusive and some measure of lateral movement in "going around" the interference(s).

3. With the patient in the centric position, a test is made to see if protrusive balance exists. Usually the anterior teeth will lift the posterior teeth out of function at the instant any protrusive movement is made.

B. *Marking the Interference:* With articulating paper bilaterally inserted so that all teeth will be marked, the patient is asked to tap in centric position and then make the proper protrusive excursion.

C. *Interpreting the Markings:* The most gingival portion of the mark on the palatal planes of the upper incisors will be the centric mark, and in any stoning, the last bit of the palatal portion of this mark is always left. (See Fig. 5.)

D. *Eliminating the Interference:*

1. The offending areas in the anterior teeth are stoned, taking care to preserve the line-to-plane centric contacts between the anterior teeth. If protrusive interference is removed by stoning on the posterior teeth, the centric contacts this time will become point-to-plane contacts.

2. The marking and stoning are repeated until a 2 mm. protrusive balance is experienced by the patient.

E. *Patient's Response:*

1. Again the patient's feeling is a good guide, if the operator is careful to see that no "protective" movement laterally is made.

2. Several quick excursions from centric position forward two millimeters should elicit from the patient the comment that it feels "even, smooth," and that "all my teeth are working."

V. *Fifth Procedure: Functional Chewing and Final Testing.*—

Functional damage is done within a close (two-millimeter) range of the centric position. For example, in close, heavy chewing of such foods as fine, tough meat fibers, apple skin, tough bread crust, hard kernels of popcorn, etc., when the teeth are actually milling and pulverizing the food, and are in close contact with each other, the chewing strokes are repeated many times, each stroke following the reflex chewing-stroke pattern.

REFLEX CHEWING-STROKE PATTERN

1. The jaw opens and moves laterally toward the functioning (working) side as the tongue and cheek collect the bolus and place the food on the teeth.

2. The jaw starts movement superiorly and medially until the teeth meet on the working planes roughly two millimeters or less from the centric position, on the functioning side.

3. The jaw continues superior-medial movement, with working planes in contact, to and through the centric position, moving laterally then in the opposite direction with the teeth riding the balancing planes of the functioning side for two millimeters. (A complementary support only is the role of the teeth on the opposite [balancing] side of the mouth [the side which is not being used for chewing at the moment]. Balance, per se, in the light of the foregoing, is actually a chore for both balancing and working planes of this nonfunctioning side.)

4. The jaw opens and the process is repeated.

It is impossible for a patient, however mechanically inclined, however familiar with occlusion and anatomy, to move the jaw deliberately in the manner that he will during mastication. His functional movements are invariably different from his deliberate movements. When the musculature is used in a reflex fashion, i.e., heavy unilateral contraction on the side on which the bolus is being masticated, the condyle on that side seems to have a direct, superior movement as it climbs the medionaterior wall of the glenoid fossa after the patient passes the centric position in the chewing stroke, and the teeth ride the balancing planes as described.

Some patients can get an approximation of this movement if asked to "squeeze" the balancing side hard when making a deliberate lateral excursion. In others this seems impossible.

At least half of the function in close, hard mastication takes place on the balancing planes of the posterior teeth on the functioning side, after they have crossed the working planes and through centric position during each chewing stroke. The inability of patients deliberately to reach, point up, and register markings of interferences on these balancing planes makes this a difficult problem. It can be solved by a "functional chew-in."

The wax used for the "functional chew-in" should be tough, requiring heavy muscle-pull by the patient to chew it. Dr. Peezo's Stick-wax for Crown and Bridge (S.S.W.), slightly warmed before insertion in the mouth, is the author's choice for this purpose.

A fine abrasive dust (Oranite 10 aluminum oxide dust) is placed in the mouth, too, at regular intervals during the "chew-in". The purposes of introduction of this abrasive into the mouth are: (1) To roughen all the functioning planes slightly so that they (planes) will have a uniform texture (this slight roughening will greatly intensify the patient's perception of contacts of the opposing teeth during the chewing). (2) To mill out interferences so minute as to be next to impossible to eliminate by stoning.

A. *Educating the Patient:*

1. In all the foregoing procedures, the patient, at the suggestion of the operator, has been deliberately exploring for interference, and by this time is very "occlusion-conscious." His attention must now be called to the fact that when the wax and abrasive are inserted in his mouth, and he is asked to masticate, he must do this as if he were actually chewing food rapidly.

To suggest to the patient that if he thinks of "grinding up small pieces of meat" or some similar material requiring heavy, close function, it would help him to do this. He is reminded occasionally about this "thought of actual food chewing" during the procedure. Most patients will "slow-down" to try to diagnose the sensations they experience, thus destroying the reflex nature of the masticatory action.

B. *Marking the Interference:* Markings are postponed for the time being. The patient is asked to chew on one side, rather rapidly and with hard, heavy, milling action.

1. The movements of the teeth are observed by the operator by sighting along the buccal and labial surfaces of the teeth first on one side and then the other

as this unilateral reflex masticating is done. Excessive, sporadic movements of individual teeth and in which parts of the reflex-chewing-pattern they occur are noted *in writing.*

2. The procedure is repeated on the opposite side.

3. The insertion of articulating paper while reflex-chewing is taking place is in some instances impossible. However, with an experienced patient, *cooperating well,* this frequently can be accomplished. Particularly is this true of the interferences between the balancing planes on the nonfunctioning side. Interferences on these planes are readily demonstrated by inserting articulating paper on the nonfunctioning side while the patient chews the wax on the opposite (functioning) side. The operator's experience and ability at patient management are factors in this instance. Sympathetic and forceful encouragement helps the patient in this procedure.

The repeated observation of worn facets at later dates can be relied upon as absolutely accurate markings. So, notations of irregularities in the tooth movement, (the interferences producing which irregularities are not at this time demonstrable by articulating paper markings) should be written, to be referred to at later sessions, when facet observation is made.

C. *Eliminating the Interference:* If markings can be obtained at this time, corrections are made by stoning, with care not to disturb the now familiar "centric" point-to-plane contacts. This is repeated until the operator is pleased with the result and the reaction of the patient to the "sound" elicits his favorable comment: "all my teeth are working as I chew."

If markings cannot be registered, the patient is dismissed until facets are produced by his natural mastication. At a later sitting these facets can be interpreted and correction made as indicated.

MAINTENANCE

Since occlusion of the natural teeth is an ever-changing, physiologic entity, maintenance of the corrected occlusion in the years following is accomplished by a careful review of the procedures in the manner described once each year, and the suitable minor corrections made.

1100 Hill St.,
Ann Arbor, Mich.

Note: In an attempt to minimize confusion and complication, and since in the main, the principles of the method presented are a departure from "classic" considerations, a bibliography is omitted.

INTRAORAL AND EXTRAORAL PHASES OF DENTAL PROTHESIS

JOEL FRIEDMAN, D.D.S.

Brooklyn, N. Y.

THE BIOLOGIC AND THE MECHANICAL

PROSTHETICS, more than any other phase of our daily practice, embraces both physiology and mechanics. The physiologic aspects include all the biologic laws to which living tissues are subject in function. These encompass the actions and reactions of the teeth with their sensitive pulps, the supporting structure of alveolar bone, the periodontal membrane, the mucous membranes, the salivary and mucous glands, the many muscle fibers and their attachments, the basal bones which are the superior and inferior maxillae, and the condylar relationships. All of these are nourished, maintained, and motivated through a complex system of nerves, blood vessels, and lymphatics. It is absolutely essential that these be maintained in an unstrained physiologic state in order to insure the success of a prosthetic restoration.

The physical aspects of oral prostheses consist broadly of noncorrosive metals, chiefly gold and the chrome alloys, and acrylic resins. These are subject to the laws of mechanics, especially in the field of statics, and function in accordance with their physical properties.

When we consider the realm of interaction between these two spheres, the physiologic and the mechanical, it is found that the problem increases rapidly in complexity. The forces of mastication, speech, and facial expression make considerable demands on the oral tissues, as well as on the prosthetic appliances. The prosthesis itself almost invariably applies an increased load on the dento-alveolar arch. This is due to its attachment to the natural teeth when these are utilized as supporting abutments, and to the mucosa where there are tissue-supported saddles, in addition to the greatly increased function attendant on the placement of an appliance.

No matter how the stresses originate, nor how they produce interaction between the oral parts and the prosthetic parts, the entire strain is eventually charged to the alveolar bone. The teeth, the mucosa, the gingivae, and the prosthetic

Reprinted from The New York Journal of Dentistry, 23:15-17, 1953.

Presented before the Second Workshop on Trends in Dentistry-Laboratory Relations sponsored by the First District Dental Society, Oct. 31, 1952, Hotel Statler, New York.

appliance usually experience their share of strains. The teeth may suffer attrition, caries, and pulpal damage; the mucosa and gingivae may develop inflammatory and atrophic changes. The prosthesis may experience bending, or wear of its parts. But the significant residual tissue damage accrues in the bony abutment sockets, and in the bone underlying the edentulous ridge.

THE DENTIST AND THE TECHNICIAN

Parallelling this scheme of prosthetic dentistry, we have, in our present pattern of dental practice, the *dentist* who makes the oral diagnosis for the patient and prescribes the prosthetic remedy. In brief, he prepares the mouth and makes the impressions and other registrations, and in the case of a partial denture, chooses the materials, and selects a few likely abutments for clasping.

The *dental technician* then surveys the teeth for undercuts, outlines the design, and proceeds to construct the partial denture. One might assume that the technical problems of constructing a case to fit a stone cast have been largely overcome, but we often tend to ascribe a validity to the body of knowledge in a field with which we are relatively unfamiliar. This feeling is usually not at all shared by those who are active in that field. There is a great deal of what we might call temperament in the materials which the technician employs. However, we may assume a properly processed appliance fulfills the plan which the technician has set forth.

We have graphically delineated the *oral phase,* the problems of physiology, which represent the responsibilities the dentist usually assumes, and the *extra-oral phase,* the technical problems, which are largely relegated in some areas to the technician.

THE PROFESSIONAL MAN'S RESPONSIBILITIES

There remains the aforementioned realm of interaction between these two spheres which requires elucidation. Every concept must have its starting point. We usually set forth certain truisms, and if these be accepted, then the conclusions derived must also be admitted to be true.

I present as the first axiom the statement that in the interaction of an oral appliance functioning within a dental arch, the significant damaging effects are in the alveolar bone. The second axiom is that in the rendering of an oral health-service, it is the relationship between the professional man and the oral health of his patient that is the supreme responsibility of the dentist. If we accept these truisms, then it must follow that the present division of duties is *not* in accord with the obligations of the dentist to his patient.

Every practitioner must retain the function, in prosthodontics, of thoroughly analyzing and exposing *all* the problems, both physiologic and mechanical, inherent in a case, evaluating the nature and magnitude of these problems for the individual case, and planning the restoration to the last detail, in a manner which will restore a maximum of function to the mouth while providing a safe margin of physiologic tolerance. This is a responsibility which must never be relegated in whole or in

part to the technician, whose judgment is based entirely on the appearance of the casts and the use of a surveying instrument. The limited, mechanistic concept of the technician is all too frequently directed to the construction of an appliance of unobtrusive design and pleasing finish which will fit into place and evoke a minimum of criticism from dentist and patient. For a technician, whose background is entirely lacking in knowledge of oral physiology, these aims may suffice. The approach of the professional man on the other hand, must be deep in its probing, broad in its understanding, and far-reaching and creative in its application.

PROFESSIONAL DIAGNOSIS AND TREATMENT PLANNING

The dentist must continually sharpen his diagnostic acumen to insure the elimination of all real and potential oral pathosis. Beyond this, he must know the bio-mechanical stresses and strains introduced by the presence of prosthetic appliances and their parts in the mouth. He must visualize the anticipated stresses resulting from the chewing cycle of the individual being treated, from the dislodging influences of the tongue and facial musculature of that patient, and of the potential damaging effects of horizontal stresses to abutments and ridges of the parts of the appliance which he plans. When these stresses have been carefully evaluated, and recorded for type and magnitude, when the size and location of the missing segments have been noted, and the worthiness and distribution of potential abutments have been appraised, then the dentist is ready to survey the case.

The technician, in surveying a case, usually is engaged in a search for undercuts suitable for the placement of retentive clasp tips, so that the case may be inserted easily, remain in place under oral stresses, and be removable readily at the desire of the patient. These aims fall far short of the potential service which might be incorporated by the dentist who is armed with a complete stress analysis of the patient's requirements. A dentist who has a full understanding of the problems, of the means available, and of the procedure for applying the means could proceed to design a denture in which the physiologic aims of prosthetic dentistry were more truly applied than would be possible for a technician. His supportive, or rest, elements could be designed with an appreciation of improving the direction of occlusal forces along the long axes of the teeth, of designing retentive units in which the active resilient tip functions only when needed to prevent the oral dislodging forces from lifting the denture from its seat, and not during the exertion of masticatory or clenching forces, and the incorporation of horizontal stabilizing elements which would function without introducing destructive lateral stresses at or near the occlusal surfaces of the teeth.

Saddle coverage could be planned to satisfy the requirements of the patient as they applied to the apportionment of tooth and tissue bearing, in accordance with the dentist's estimate of chewing stresses and the quality of the bearing surfaces. Saddle design which would largely eliminate coverage of the so-called "playground of the tongue," the central rugae behind the upper anteriors, would improve phonetics. Judicious incorporation of these elements of design can only be effected by the dentist who has studied and recorded his analysis of the individual problems,

and then proceeds to apply them for the individual patient. The dentist should then give a work authorization form to the technician which bears the complete design of the denture, with instructions for materials, and perhaps a few notes on variations in thickness or resiliency of parts. I conceive this to be the responsibility of the dentist. It extends far beyond the intraoral phase of impression and registration of occlusal relations. It encompasses all of the extraoral phase *except* the actual fabrication and finishing of the replacement appliance. The technician's responsibility, then, as an aid to the dentist, is the actual *processing* of the appliance according to the dentist's directive.

CONCLUSION

No plan incorporating less than is embodied in this concept is valid for the profession of dentistry. These standards represent the minimal responsibilities of the dentist, and the maximal responsibilities of the technician in the practice of dentistry. Let this be our aim and our objective in the practice of oral prosthesis.

499 Lincoln Place
Brooklyn 38, N. Y.

INVESTMENT CHANGES DURING FLASKING AS A FACTOR OF COMPLETE DENTURE MALOCCLUSION

SIGMUND A. PERLOWSKI, D.D.S.

Veterans Administration Hospital, Kerrville, Texas

THE INCREASE of vertical dimension as a result of full denture fabrication has been recognized and studied by many investigators. A great deal of information has been compiled as a result of these investigations, but no standardized technique has evolved to entirely eliminate this discrepancy.

Grunewald[1] states that the most likely factors causing the increase of vertical dimension after processing are: (1) excess acrylic resin in the mold at the time of final closure, (2) too rapid closure of the flask to permit a normal flow of the acrylic dough, (3) processing in a "green" all plaster of Paris mold, (4) use of a thin mix of plaster of Paris in investing the cast, (5) failure to use a spring clamp during curing which might permit expansion of the acrylic resin without distortion of the mold.

Mahler[2] found that: (1) acrylic resin, at the final closure of the flask, has sufficient internal shear resistance or viscosity to allow severe stress distributions in the uncured denture. The practical manifestation of this unequal stress condition is a shifting of some teeth more than others. (2) Increased vertical dimension to a minimum of 0.6 mm. was found to depend on the pressure in the acrylic resin. (3) Increased vertical dimension to a minimum of 0.6 mm. was found to depend on the material used in the splint, or third pour of the flask.

The hardness of the investing material, the resistance or excess of the acrylic resin, and stresses and strains of curing have been considered as factors manifesting inarticulation, but to my knowledge, very little thought has been given to a possible change during the investing process. It is reasonable to believe that the expansion of and heat liberated by the setting investment material is sufficient to move the teeth in their wax foundation. Pursuing this reasoning, some observations and experiments were attempted on twenty-five practical dentures.

The first group was flasked in the conventional manner, that is, the first pour of plaster was to invest the cast in the lower member of the flask. The second pour of plaster was up to the occlusal surfaces of the teeth, and the final or third pour of stone was to form a splint against the occlusal surfaces of the teeth.

The second group was flasked in the same manner, except that preceding the flasking a thin mix of stone was painted on the surfaces of the teeth with an inlay brush. This matrix or core was allowed to set before proceeding with the remaining flasking procedure.

Received for publication Jan. 23, 1953.

In the third group, plaster was used as the matrix around the teeth.

All dentures were returned to the articulator after curing, and the amount of opening at the incisal guide pin was measured and recorded. The results are shown in Table I.

TABLE I.

GROUP 1 CONVENTIONAL FLASKING	GROUP 2 STONE MATRIX	GROUP 3 PLASTER MATRIX
AMOUNT OF OPENING (MM.)	AMOUNT OF OPENING (MM.)	AMOUNT OF OPENING (MM.)
1.5	0.5	0.0
0.7	0.0	0.0
1.3	0.75	0.7
1.0	0.7	0.5
1.0	0.8	0.0
1.4		0.4
		0.5

It appears that the matrix decreased the amount of pin opening, and that the plaster matrix was more effective than the stone matrix. This seems to indicate that the hardness of the investment has little effect on the movement of the teeth. Since this is contrary to the findings of other investigators, it was thought that there might have been an inconsistency in our technique.

In order to check these observations, edentulous casts were mounted on an articulator. The upper cast was duplicated twice, and these duplicate casts were mounted with the same wax occlusion rim so that all three had identical relations to the lower cast. Teeth were set into the lower wax occlusion rim, and it was removed from the articulator on its cast and processed. After curing, the lower cast and denture were returned to the articulator. Teeth were arranged on three wax occlusion rims on the three upper duplicate casts to occlude with the teeth on the finished lower denture. Each of the upper dentures was flasked on its respective cast by a different method. The flasking was done by (1) the conventional method, (2) with a stone matrix, and (3) with a plaster matrix. All three flasks were packed and cured under identical conditions. The dentures on their casts were returned to the articulator, one at a time, and the amount

TABLE II.

METHOD OF FLASKING	AMOUNT OF OPENING WHILE ON THE CAST (MM.)	AMOUNT OF OPENING AFTER RESEATING ON CAST (MM.)	DIFFERENCE (MM.)
Conventional	0.4	1.2	0.8
Stone Matrix	0.25	0.9	0.65
Plaster Matrix	0.0	0.6	0.6

of opening at the incisal guide pin was measured and recorded. The upper dentures were then removed from their casts and reseated upon them. The amount of opening at the incisal guide pin was measured once more (Table II).

These results indicate that the use of a plaster matrix around the teeth is the most accurate of the flasking methods measured. The difference in the amount of opening of the pin, before and after the dentures are removed from the casts, is probably the result of the internal strains in the base material which are developed in the curing process. The removal of the dentures from the casts would permit the internal strains to deform the dentures. The matrix investing technique showed the least change. This may mean that this method may decrease the amount of internal strains caused by curing.

CONCLUSIONS

1. There is sufficient evidence to indicate that there is some shifting of the teeth during the investing procedure.
2. A plaster matrix prevents the shifting of teeth during flasking.
3. A matrix eases the separation of the investment from the finished denture.
4. A plaster matrix may diminish the internal strains of curing.
5. The close adaptation of the investment by the "brush-on" method is more important than the hardness of the material used.

REFERENCES

1. Grunewald, A. H.: The Effect of Molding Processes on Some Properties of Denture Resins, J.A.D.A. **44**:269-287, 1952.
2. Mahler, D. B.: Inarticulation of Complete Dentures Processed by the Compression Molding Technique, J. Pros. Den. **1**:551-559, 1951.
3. Skinner, E. W.: Acrylic Denture Base Materials and Their Physical Properties and Manipulation, J. Pros. Den. **1**:161-167, 1951.
4. Mahler, D. B.: Hardness and Flow Properties of Gypsum Materials, J. Pros. Den. **1**:188-195, 1951.
5. Steck, N. S.: Measurements of Vertical Dimension of Processed Dentures, J. D. Res. **26**:616-621, 1950.

Veterans Administration Hospital
Kerrville, Texas

ATTAINING AND MAINTAINING MOUTH HEALTH

ORVILLE B. COOMER, D.D.S.

Louisville, Ky.

THE title of this paper does not speak of complete mouth reconstruction or oral rehabilitation or complete mouth restoration. All of these usual titles for a discourse such as this contain the Latin prefix "re" which means or implies a return to a former state. There is of course some difference in the meaning of these words, but the difference is largely one of degree, and when any one of them is used to describe a dental procedure, it is clearly implied that an attempt is to be made to return the teeth and associated structures to their former condition. This would indeed be a laudable undertaking if the former state were one of perfection. It is safe to assume, however, that it was not, and that at least the predisposing factors to disease and destruction were present; otherwise, extensive dental treatment would not now be needed. If an individual is born with perfectly functioning legs and feet, he has no need for an orthopedic surgeon to correct a club foot or other joint deformity. The very fact that an extensive operation of this kind is necessary presupposes an original dysfunction which should not be restored, nor reconstructed, nor rehabilitated, but corrected so that a normal function can be attained.

The conception of what constitutes complete mouth restoration or rehabilitation will vary greatly with different individuals. It will vary according to their training, experience, knowledge, and special interests; in every case it will be directly proportional to the individual's understanding and appreciation of oral physiology along with his conception of what constitutes a normal function of the jaws and their component parts.

The expert and enthusiastic gold foil operator might consider the mouth completely restored when all the pits and fissures were perfectly filled, all carious processes removed, and the subsequent placing of proper restorations done.

The orthodontist might consider the mouth rehabilitated when he could demonstrate by means of beautifully trimmed casts that the teeth were all in perfect alignment, and that each cusp and fossa was in its correct position. The restorative man might consider the mouth completely reconstructed when all broken-down alloy fillings had been replaced with perfectly fitting gold inlays, and all missing teeth had been restored by means of fixed or removable partial dentures.

The periodontist might be very happy when he sees the gingival tissue become pink and firm following a radical gingevectomy. He might assume that he had

Read before the American Academy of Restorative Dentistry, Chicago, Ill., Feb. 7, 1953. Received for publication Feb. 20, 1953.

attained mouth health. He often finds, however, that maintaining it is a disappointing experience.

The nutritionist might consider the job done when he had completed a thorough diet analysis, and had placed the patient on the correct dietary regimen.

The practitioner of oral medicine might consider that he had attained complete oral health when all infections and other pathologic processes had been removed.

When all of these have failed, the exodontist is called in, and of the entire group he is the only one who knows for sure when he is through.

The prosthodontist now takes over and makes dentures, or beautifully functioning artificial counterparts of human teeth and supporting structures, according to his knowledge and conception of oral physiology, his appreciation of the artistic, and his knowledge of the normal function of the jaws.

And last but not least, the economic genius considers the case a complete success when the bill is paid in full.

The intriguing part of the whole picture is the fact that the exponent of almost any technical procedure for mouth rehabilitation can exhibit patients who have been treated according to his particular method, have rapidly returned to a state of oral health, and so remained. He concludes, therefore, that he has the answer, and proceeds to tell the world. He does not show, or even mention the often large percentage of those patients who, when subjected to the same method of treatment, are either complete failures or at best demonstrate only temporary and transient improvement.

The orthodontist can submit patients who demonstrate beautiful tooth alignment and good occlusion long after all treatment appliances have been removed and all retainers have been discontinued. He doubtless has many other patients who were diagnosed by the same method and treated by the same type of appliance, who have relapsed to or beyond their former state.

The nutritionist can cite the case of patient A, who after a thorough diagnosis was placed on diet X along with the correct supplements, and thereby achieved a state of perfect health. He might also review the case of patient B, who after the same diagnostic routine, and apparently the same nutritional deficiency, not only failed to respond to diet X, but got steadily worse during its administration.

The prosthodontist can bring in his prize patient who not only could eat corn off the cob thirty minutes after acquiring his complete dentures, but five years later can crack nuts and open an occasional beer bottle without the slightest displacement of either base. The patients not likely to be asked to the demonstration are those who, even though their dentures were constructed according to the same careful procedure, have difficulty with even the softest foods.

The exodontist may truthfully state that by following a given technique he is able to carry most of his patients through multiple and difficult extractions with an absolute minimum of discomfort; but if he is completely honest, he will admit that by following the same procedure, he also has some dry sockets and an occasional osteomyelitis.

All of the variations mentioned and many others have long been observed by practically all dentists in active practice. The fact that by following the same technical procedures a wide variety of results are achieved cannot be questioned. The big question which confronts all thinking individuals is, why is this so?

The complete answer is not now known, nor is it likely that it will ever be known. Dentists are called upon to attempt to diagnose, to treat, and to correct abnormalities, pathologic conditions, and physiologic dysfunctions of a part of the most complex organism which the Almighty in His infinite wisdom has so far created. It is an organism which has resistance, adjustability, adaptability, and the ability to repair itself; an organism which is materially affected by the type and amount of nutritional substances which enter its complex and mysterious biochemical laboratory, and which is profoundly influenced by the thought processes which are generated in its brain and autonomic nervous system.

These factors, along with hereditary influences, variations in glandular function, metabolic disturbances, and many other known and unknown equations, suggest some possible reasons for the wide variation in clinical results following the application of the same therapeutic measures or technical procedures.

This wide and complex variation of known and unknown factors possibly accounts for the honest differences of opinion and lack of agreement as to what is the best treatment or procedure for any given patient. About the only problem on which there is universal agreement is that of the completely edentulous patient. All dentists agree that dentures are indicated. They would not, however, completely agree on any one step in the technical procedures necessary to supply the dentures. The fact that all techniques in use today are capable of producing a wide variation in results indicates that they all contain a part of the truth, and none embodies the whole truth.

Since, therefore, the problem is one of great complexity, and since there is little or no agreement as to the best methods and procedures for its solution, what are dentists to do? What is their obligation to those who seek their advice and service?

If the dentist is to be a physician to the mouth, and a professional man in its highest meaning, it is his definite obligation to have a working knowledge of the known scientific facts that influence or should influence every operation which he attempts. It is not enough that he be familiar with the truths that are known about his own particular field; he must also have an understanding of the systemic factors that influence every operation and technical procedure which he may do.

He must have a thorough knowledge of the anatomy, histology, and physiology of the jaws and associated structures. He must understand the physiologic function of the temporomandibular joint, and that of the muscles which are responsible for its motivation. He must understand the harmony which should exist between cuspal interdigitation and mandibular centricity. He must be able to recognize any lack of such harmony and accurately predict its possible effect on the mandibular joint, the teeth, and associated structures. He must have a thorough knowl-

edge of the pathologic changes that may occur in the joints, jaws, teeth, and supporting structures, along with their known etiologic factors.

In addition to a knowledge of the scientific facts which are known about his particular field, the dentist must also recognize that all of his treatments and operations are affected and influenced by many known and unknown systemic factors, among which are heredity, diet, metabolism, glandular function, and the mental processes of his patient. He must realize that the mouth is often the cause of systemic and mental disturbances, and that it is frequently the victim of them.

It is obvious that the attainment and maintenance of mouth health, in some patients at least, will require the application of an extensive and wide variety of scientific knowledge. It is also obvious that few dentists have the time or the talent to become proficient in all the diagnostic and technical procedures which may be necessary if their patients are to enjoy the permanent benefits of mouth health. Assuming that it is possible for a dentist to become a good psychiatrist, an expert in nutrition, an accurate diagnostician of systemic disturbances, and a master in his own technical field, it would still be impractical for one man to attempt to practice all of these branches of the healing art. If he attempted to render complete and adequate service in all these fields, he not only would reduce the number of his patients to an impractical minimum, but would deprive many of the much needed specialized services which only he can render.

What then is the ideal procedure for attaining and maintaining mouth health? The dentist may achieve this goal without a thorough knowledge of all the systemic and mental factors that influence the health of the oral cavity and its contents. If, however, he is to obtain the maximum results in oral health, he must be able to recognize the degree of influence exerted by these extrinsic factors in any given patient. In other words, he must be able to determine whether his problem is largely systemic, entirely local, or a combination of the two. If he decides that nutritional deficiencies, systemic disturbances, or mental abnormalities are major etiologic factors, he will generally render a far better service to his patient by seeking expert help in these fields. He must also realize and be able to recognize the abnormalities in his own field that may in turn be the sole, or at least a contributing factor to some types of nutritional, systemic, and psychiatric problems.

Once these problems are recognized and understood their solution lies in the proper treatment, which may be a very simple or a very complicated procedure. If the problem is largely systemic, nutritional, or psychotic, these factors should be treated and under control before any strictly dental procedures are attempted. If the patient is suffering from a complex combination of systemic and local factors, best results are generally obtained by starting and carrying along at the same time both the systemic and local treatments. If the major etiologic factors of the patient's difficulty are strictly of dental origin, the diagnosis and correction should be attempted with only a minor consideration of other influences and disturbances, as these will generally disappear if the dental treatment is correctly done.

What then is correct dental treatment? It certainly is not the introduction of some new technique, instrument, or material. During the past twenty-five years, an amazing number of extremely accurate technical procedures have been developed and introduced, but a knowledge of these does not make a dentist any more than a microscope and some stains make a pathologist.

If correct dental treatment is to be instituted, the dentist must consider the mouth as a functioning organ that is subject to the same physiologic laws that govern other parts of the body. He must be able to recognize abnormal function, must realize that abnormal function in any part of the body tends to destroy that part, the teeth and jaws being no exception. He must acutely be aware of the fact that an operation or restoration on a single tooth, if improperly done, may become the predisposing factor in the destruction of the entire dental organ.

The dentist must have an accurate working knowledge of such terms as mandibular centric, acquired centric, centric relation, centric occlusion, cuspal harmony, rest position, hinge axis, physiologic occlusion, pathologic occlusion, condylar guidance, balanced occlusion, Bennett movement, occlusal curves, and muscle tensions. When these terms are thoroughly understood, the dental diagnosis of any given case becomes a matter of careful routine. After the diagnosis has been accurately made, the necessary corrections suggest themselves and are accomplished by the application of known techniques which already have stood the test of time.

This concept of considering and treating the entire dental mechanism as a functioning unit is relatively new and is still not a major part of the curriculum in many of our dental schools.

About thirty-five years ago, two men, widely separated geographically, and without knowledge of each other's work, realized that something was lacking in the accepted concept of dental practice. They observed that many patients went regularly for dental service, were the recipients of excellent mechanical and esthetic restorations, yet they slowly, and in some cases even rapidly, lost their teeth. These two pioneers set to work to try to find the reasons. As a result of their research and study the whole concept of the practice of dentistry is changing rapidly. The profession is beginning to develop a philosophy that transcends the mere filling of holes and spaces. The dentist is becoming a physician to the mouth, and is beginning to be recognized as a leader in one of the most important and perhaps the most difficult specialties of medicine.

One of the men was Dr. George S. Monson[1]. Monson developed the spherical theory of occlusion. He gave the profession the Balanced Occlusal Guide, and the flat or cuspless tooth. All of the present forms of frustrum, inverted, and cuspless teeth were inspired as a result of Monson's research. His major contribution, however, was not spheres, curves, or teeth; it was his concept that the dental mechanism was a physiologically functioning organ, and that it must be diagnosed and treated as a whole.

The other pioneer in this concept of mouth health was Dr. B. B. McCollum[2]. McCollum gave to the profession proof of the existence of the hinge axis, along with an accurate device for locating it. He gave the first accurate definition of

true centric relation and demonstrated the difference between mandibular centric and so-called "acquired centric." He proved the very great importance of the Bennett movement, and devised a way to construct anatomic occlusal surfaces that would be harmonious with its influence. He developed a recording apparatus and an instrument whereby a dentist could not only accurately determine the functional movement of the jaw, but could diagnose any given abnormality of mandibular function or occlusal disharmony and subsequently restore it to its best physiologic function. As important and fundamental as these things are, McCollum's greatest contribution was his belief that the jaws and associated structures were all a part of a complex physiologically functioning organ, and that it must be studied, diagnosed, and treated as a unit.

McCollum and Monson differed widely in their approach to the solution of the problem, but they both theorized that the mouth must be treated as a whole, and thus took the first great step toward the goal of attaining and maintaining mouth health.

Attain is a lofty word. It implies hard work, unusual effort, and that difficulties and obstacles are to be surmounted. To use a familiar phrase, it means "an endeavor on the part of the dentist, above and beyond the usual dental procedure."

Only when the members of the dental profession have equipped themselves to go beyond this usual procedure and then do exactly that, will the great strides toward the attainment and the maintenance of mouth health be accomplished.

REFERENCES

1. Monson, George S.: Occlusion as Applied to Crown and Bridge Work, J. National Dental Association **7**:399-413, 1920.
Monson, George S.: Applied Mechanics to the Theory of Mandibular Movements, D. Cosmos **74**:1039-1053, 1932.
2. McCollum, B. B.: Fundamentals Involved in Prescribing Restorative Remedies, D. Items Interest **61**:522-535, 641-648, 724-736, 852-863, 942-950, 1939.

1006 Heyburn Bldg.
Louisville, Ky.

THE INFLUENCE OF SADDLE CLASSIFICATION ON THE DESIGN OF PARTIAL REMOVABLE RESTORATIONS

LEONARD S. BECKETT, M.D.S. (UNIV. OF SYDNEY)

Sydney, Australia

THE SUCCESS or failure of a partial denture will depend more than anything else upon the design used. This design may fairly be likened to a blueprint from which the final appliance is developed, and unless this blueprint conforms to requirements of the individual patient, technical skill of the highest order will be of no avail. In proportion, as a design fails to take into consideration the requirements which are the basis of a successful restoration, so will the efficiency and function be reduced.

OBJECTIVE

Basically, the design for a partial denture must conform to one original requirement. This is the study of the problem of distributing the energy generated by the muscles of mastication so that it will be expended at the occlusal surface with the maximum efficiency consistent with the minimum damage to the supporting structures.

CONSIDERATION OF FACTORS

In order to achieve this objective we must consider the mechanics of mastication, and the biologic and physiologic reaction of the supporting tissues to occlusal stresses when they are carrying the extra load arising from the use of a partial restoration. If we are to solve this problem of distributing muscle energy successfully, it will be necessary to examine some of the mechanical factors associated with mastication: (a) the muscles of mastication, (b) the fundamentals of tooth support, (c) the fundamentals of mucosa support.

THE ACTION OF THE MUSCLES OF MASTICATION

Reference will be made to one mechanical factor not usually stressed. At first glance it would appear that the mandible functions around the temporomandibular joint as a fulcrum. However, when the size of the temporomandibular joint is related to the force developed by the muscles of mastication, and this is compared to the load carried by joints in other parts of the body, such as the knee joint, it is hard to escape the conclusion that some protective mechanism must be

Received for publication Jan. 30, 1953.

operating. Further, it is obvious that bicuspids and molars are for crushing purposes, and the incisors and canines for incising and tearing food. In the presence of a normal complement of teeth, the main pressure is exerted in the area from the second bicuspid to the second molar with the first molar showing the maximum physical development. If physical development is evidence of a response to function, then the maximum function must be exerted, normally, in the region of the first molar, and not in the region of the third molar as would be the case if the temporomandibular joint acted as a fulcrum during the act of mastication. The masseter, the internal pterygoid, and the temporal are the muscles chiefly concerned with closing the jaw. When the action of these muscles is analyzed it will be found that, while the masseter and internal pterygoid muscles make direct pressure, the posterior fibers of the temporal muscle produce a rotary action on the mandible which relieves the temporomandibular articulation of overload.

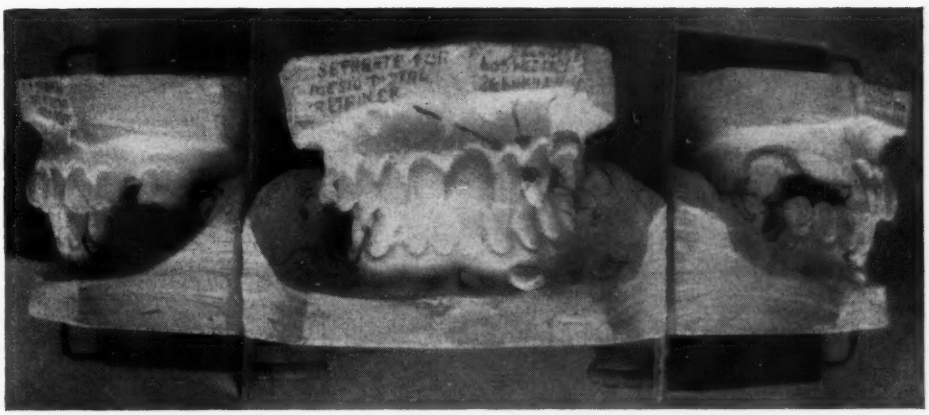


Fig. 1.—Study casts of a dental cripple aged 22 years. This condition could to a great extent have been prevented if the lost teeth had been restored within a reasonable time after extraction. The total loss of occlusal contact on the right side will increase the load on the temporomandibular joint. The mesial drift of the molar abutments on both sides has seriously reduced the efficiency of these teeth as abutments.

When we realize the significance of this physical development in the first molar region, the need for early restoration of lost first and second molars becomes more important, so that the muscular forces may be expended at the most favorable areas on the occlusal surface. Early restoration is important for the purpose of preventing other teeth from drifting into unfavorable mechanical positions where they would become less competent to carry out their work of supporting an artificial restoration and the normal functions of mastication (Fig. 1).

THE USE OF TOOTH SUPPORT

The problem of tooth support is also a mechanical one. It calls for a careful assessment of the value of all abutment teeth in terms of the quality and quantity of the bone and peridontal membrane available for their support. Another factor

that has considerable influence on the value of a tooth as an abutment is its position in relation to the direction in which the load is transmitted. The most favorable circumstance is found when most of the pressure is in the line of the long axis of the tooth. Conversely, the greater the deviation of the axis of an abutment tooth from the direction of the forces of mastication, the less satisfactory that tooth will be as an abutment for a partial denture. When assessing the value of abutments, the principle usually accepted in bridgework for this purpose makes a good starting point. When the bony support is good and the cusp height not above average, it is usually accepted that two abutments will carry the added load of two more teeth of the same size without the risk of any appreciable deterioration of the underlying bone and peridontal membrane. This is a 100 per cent overload. Under extremely favorable conditions, as much as a 150 per cent overload is permissible. With an increase in the length of the saddle and a decrease in the value of the abutments, the distribution of occlusal stresses becomes an increasingly difficult problem.

Fig. 2.—Examples of Class 1 (tooth-borne saddles). Clinical and roentgenographic examinations leave no doubt that the abutment teeth are considered competent to carry the extra load imposed by the saddles as transmitted by occlusal or lingual rests.

As these conditions grow progressively more adverse, it becomes more and more difficult to use the teeth as abutments for the total support of a denture. At the same time, the mucosa surface becomes greater in extent and more useful as a supporting medium. As it is not possible to make simultaneous use of both tooth and mucosa support for a saddle, the time eventually comes when a choice has to be made between the two. These are the problem types of saddles which are the cause of many of our failures. Any saddle area with an abutment at each end which, on detailed examination of the supporting tissues, leaves a doubt as to the ultimate success of the abutment teeth as a means of support is a problem type. It should be put in a special class and given special consideration before deciding upon procedure and design. Since saddle support by means of abutment teeth has proved the more efficient in practice, it is naturally given preference whenever possible.

THE USE OF MUCOSA SUPPORT

There are also saddles which have an abutment at one end only. These saddles obviously can never have full tooth support. It has been found unwise in many cases to attempt to support them by an occlusal rest on the abutment tooth at one end only, on account of the frequency with which the abutment tooth becomes damaged and loosened. This class of saddle, in consequence, must be regarded primarily as one receiving mucosa support alone. A technical procedure must be developed involving the use of stress-breakers to relieve the abutment teeth of overload, and a relining technique which will give the maximum efficiency possible. As the mucosa is less effective than the teeth as a supporting medium, it is more necessary than ever that there should be a careful examination and evaluation of supporting tissues in order to insure a successful result in these cases. This will call for a critical examination of the bone, its cortex, cancellous tissue, and overlying mucosa in an effort to estimate its support value. The

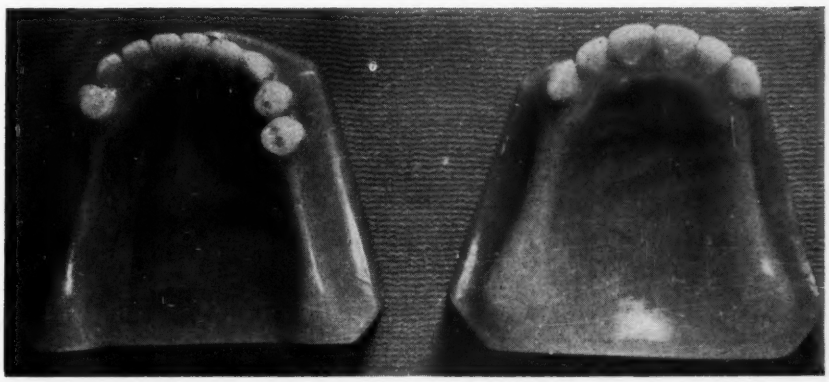


Fig. 3.—Examples of Class 2 (mucosa-borne saddles). This type is always a distal extension saddle with only one abutment. The safest treatment of this type of saddle is to make it fully mucosa borne to protect the single abutment from overload. On the rare occasions when special circumstances indicate that the load must be placed on the abutment, it must be done with due regard for all extraordinary factors involved.

maxilla is designed by nature to absorb and dissipate pressure. It is more reliable in this regard than the mandible. The maxillary bone is highly cancellous, and has a thin protective cortex covered by a fibrous layer of mucosa of varying, but usually satisfactory thickness and density. The mandible has the characteristics of a long bone, but with more cancellous tissue. Its thin, nonresilient covering of fibrous tissue resembles the periosteal covering of a long bone except that it is thicker. Its stress-bearing area, in general, is smaller than that available in the maxilla. The degree to which a saddle area can absorb stresses without trauma will vary according to the ability of the mucosa and fibrous tissues to cushion the masticating pressure, and to the extent that interference with the blood supply to the cortical bone can be prevented. The dense fibrous layer of the maxilla is naturally more effective in absorbing pressure than the thin covering of the mandible, which easily becomes inflamed when it is pinched between the bone and the denture base. Also, since cancellous bone is freely supplied with

blood vessels from within, the nutrition of the surface of the maxillary cortex can more easily be supplemented by virtue of its thinness than can the thick mandibular cortex. It is an established fact that bone in general absorbs under continuous pressure, however light. It is also known that bone is stimulated by intermittent pressure up to a point, but will absorb if such pressure becomes too great. In view of the load carried, it is not surprising to find that tissue-borne saddles need periodic relining. It is therefore reasonable to conclude that such saddles generallly overload the tissues on which they function to a greater or lesser degree. Overload on tissue-borne saddles can be reduced by using smaller teeth, fewer teeth, and narrower teeth. It is most important also, that the saddle areas should be made as large as possible in order to provide the maximum resistance to the occlusal stresses. The efficiency of the saddle area is also increased by the use of a proper system of relining before the denture is delivered.

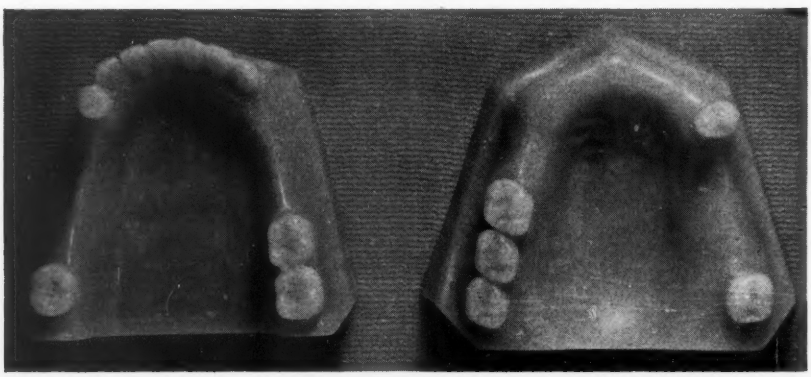


Fig. 4.—Examples of Class 3 (the problem type of saddles). Here the saddles have become so long or the abutment so weakened that full stress on the abutments would overload them. Every effort should be made by control of loading to treat these saddles as tooth-borne, failing which they should be made fully mucosa borne.

CLASSIFICATION

General considerations do not get away from the fact that we are confronted with millions of different combinations arising from the loss of one or more teeth. The vastness of the number of ways in which a partial denture can arise presents a seemingly insuperable and bewildering problem. It has been taken as a fundamental requirement that consideration must be given to distribution of muscular energy at the occlusal surfaces, and we have stated an obvious truth that tooth support is more efficient than mucosa support. It has also been stated, and can be supported on purely mechanical grounds, that these two methods of support cannot be satisfactorily combined for the same saddle. In those free-end lower saddles that appear to contradict this statement, a detailed analysis of the incidence of the occlusal pressure will show that there are circumstances and chewing habits that permit these saddles to be tooth borne on one abutment. Consequently, either the teeth *or* the mucosa should be used to support the saddles of a partial denture.

These two basic methods of support can be used advantageously as the basis of a classification for partial denture work. There are three primary types of saddle in partial denture work: Class 1 saddles which are tooth borne (Fig. 2), Class 2 saddles which are mucosa borne (Fig. 3), and Class 3 saddles, which are the "problem type" having inadequate abutments to support the saddle, and probably also inadequate mucosa support (Fig. 4). These three basic classes of saddles

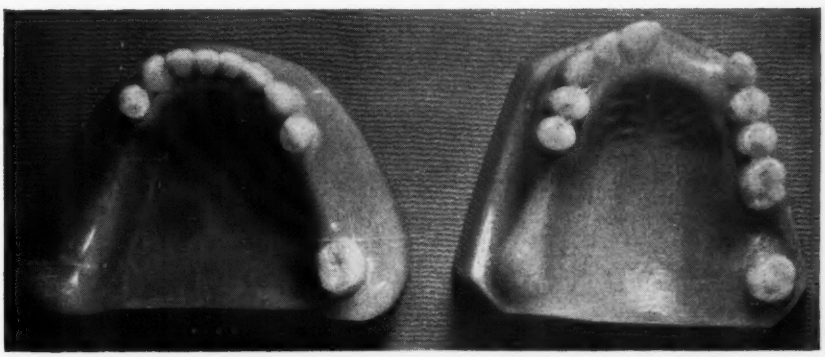


Fig. 5.—Examples of Class 1.2. (Class 1 and Class 2 saddles in combination). The Class 1 saddles are designed to be tooth borne and the Class 2 saddle(s) fully mucosa borne. The principles of design for each Class are observed by designing the Class 1 and Class 2 portions of the denture separately then joining the two designs so that each does not interfere with the function of the other.

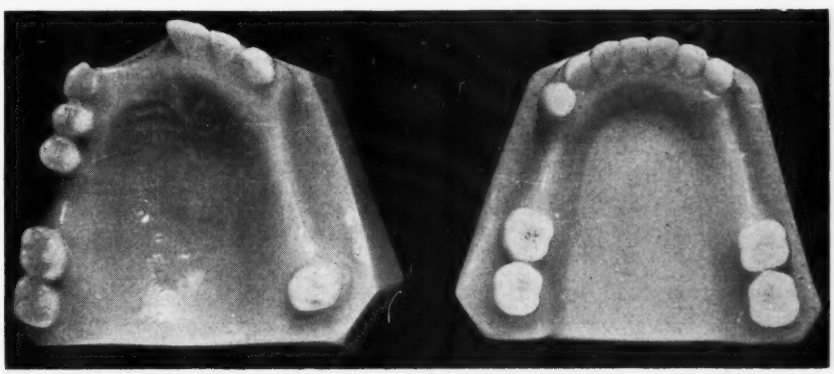


Fig. 6.—Examples of Class 1.3. (Class 1 and Class 3 saddles in combination). The first requirement is to decide whether the Class 3 saddle(s) can be treated as a Class 1 saddle(s) or must be mucosa borne. If the former, the design will be as for Class 1 cases and if the latter, the design principles for Class 1.2 cases must be used.

frequently appear in combination. Thus there are dentures which would contain both Class 1 and Class 2 saddles. These are designated Class 1.2. dentures (Fig. 5). In a similar way, there are Class 1.3. dentures (Fig. 6), Class 2.3. dentures (Fig. 7), and Class 1.2.3. dentures (Fig. 8). Therefore, partial dentures can be classified into seven groups from a functional point of view. This means that it is possible to arrange the millions of different ways in which a mouth may present

for a partial denture into seven groups. Four of these groups contain Class 3 saddles, which are to be the subject of special study before any attempt is made to design the denture.

The object of this study will be to decide whether the Class 3 saddle is to be *treated* as a Class 1 saddle or as a Class 2 saddle. This will complete the examination and diagnosis of the patient. At this stage, the denture will be designed for

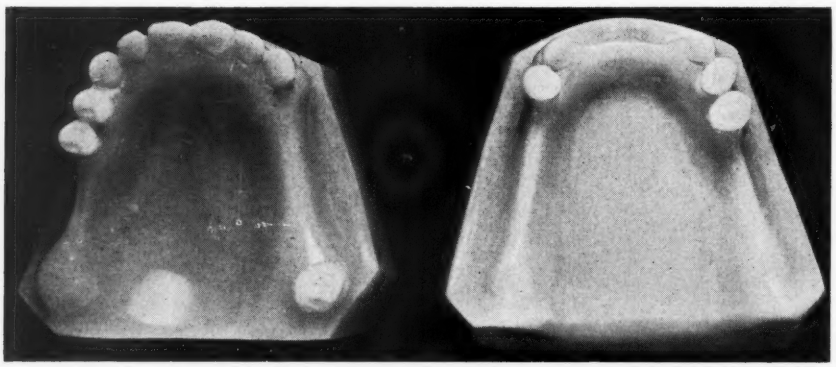


Fig. 7.—Examples of Class 2.3. (Class 2 and Class 3 saddles in combination). After deciding the treatment of the Class 3 saddle(s), the design will be the same as for Class 1.2, if the Class 3 saddle(s) is to be tooth borne, and according to the principles governing Class 2 if the Class 3 saddle is to be mucosa borne.

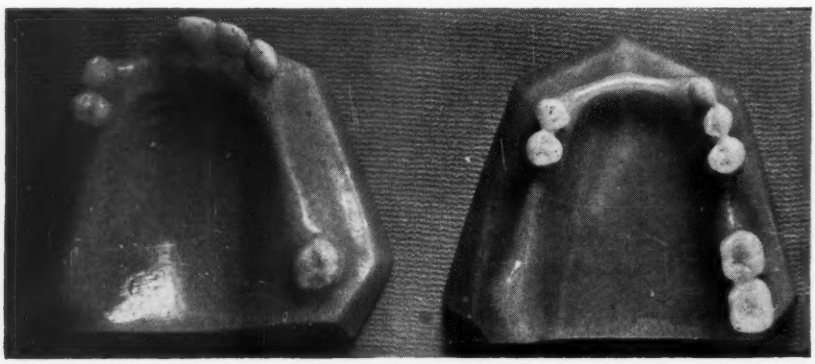


Fig. 8.—Examples of Class 1.2.3. (all 3 types of saddle in combination). Since Class 1 and Class 2 saddles are present, Class 1.2.3. is always treated as Class 1.2. irrespective of whether the Class 3 saddle requires treatment as a Class 1 or a Class 2 saddle.

laboratory procedure as if it were a Class 1, a Class 2, or a Class 1.2. denture, according to the method of support selected for each saddle. The prognosis will be favorable in proportion as the diagnosis has been correct. This results in a great simplification of laboratory and technical procedure, because rules can be laid down so that the design and construction of each type of denture becomes almost a routine matter. Having decided upon what may be called the "laboratory classification" of the denture, it is now possible to proceed with the design according to plan, in order to meet the requirments of each particular patient. The following is

a broad outline of the requirements of each of the three types of dentures. It is not possible at this juncture to enter into a discussion of all the finer points of design; nevertheless, a short review of the basic requirements of design will serve to show how design is influenced and simplified by a satisfactory classification.

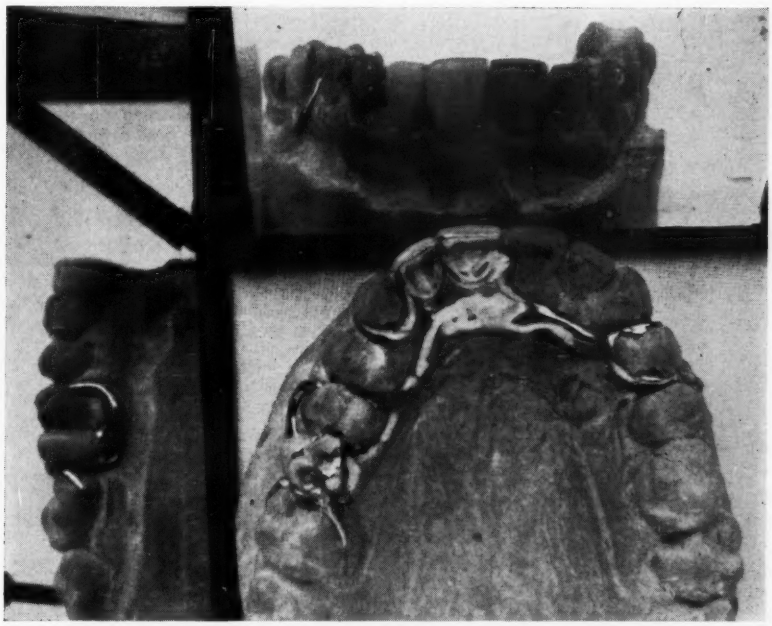


Fig. 9.

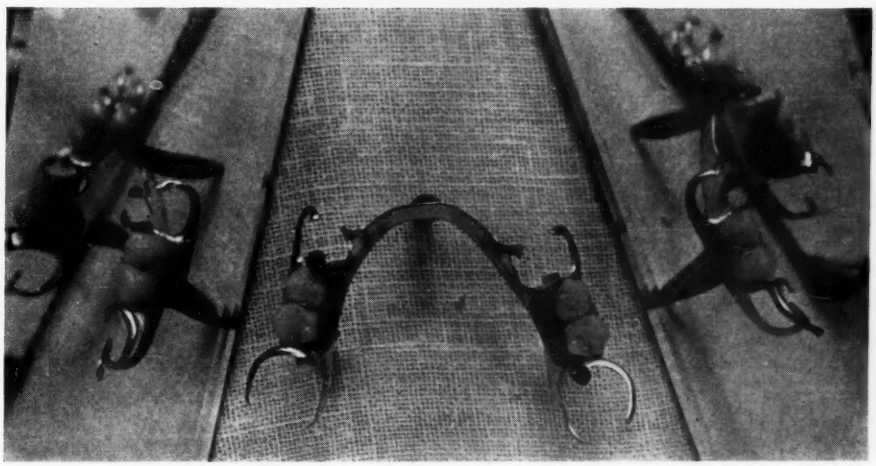


Fig. 10.

Figs. 9 and 10.—Typical maxillary and mandibular Class 1 designs incorporating in order of design sequence: (a) occlusal or lingual rests, (b) struts from occlusal rest to saddle, (c) saddles, (d) bars joining saddles, (e) a system of retention selected to suit the individual requirements.

DESIGN

All Class 1 dentures are tooth borne. This requirement takes precedence over all others in the design of Class 1 dentures; consequently, the occlusal rest is the first unit of the proposed denture to receive attention. (It is presupposed that

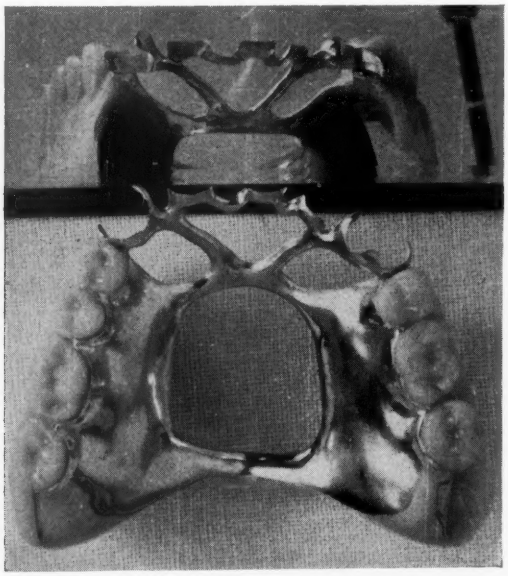


Fig. 11.

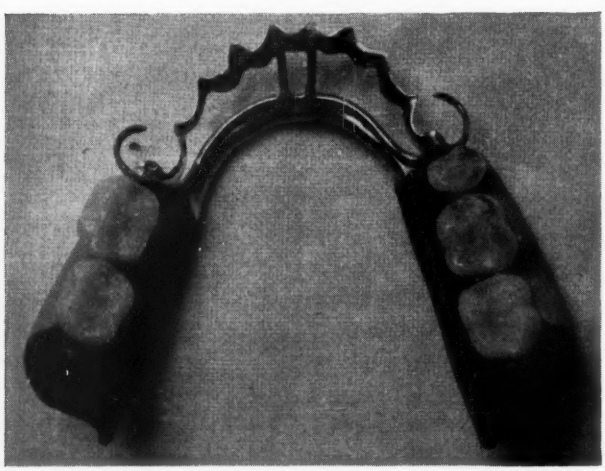


Fig. 12.

Figs. 11 and 12.—Class 2 (maxillary and mandibular dentures). The design sequence for this type of denture is, (a) outline the largest possible stress-bearing mucosa saddle area; (b) if two saddles are present, they are joined by one or two connecting bars as may be required; (c) the retainer system, direct and indirect, is planned; (d) connect the retainer system to the saddle and connecting bar portion of the designs at a point sufficiently remote from the abutment teeth so that only a harmless fraction of the load on the saddles is transmitted to the abutments.

steps have been taken during the preparation of the mouth to make adequate provision for the placing of occlusal rests to transmit the occlusal load to the abutment teeth.) The strut leading from the occlusal rest to the saddle is then given consideration. The next unit of design is the saddle to support the tooth. This need be only large enough to form a base for the tooth. When these three units are being designed, they should be so arranged and placed that the load arising

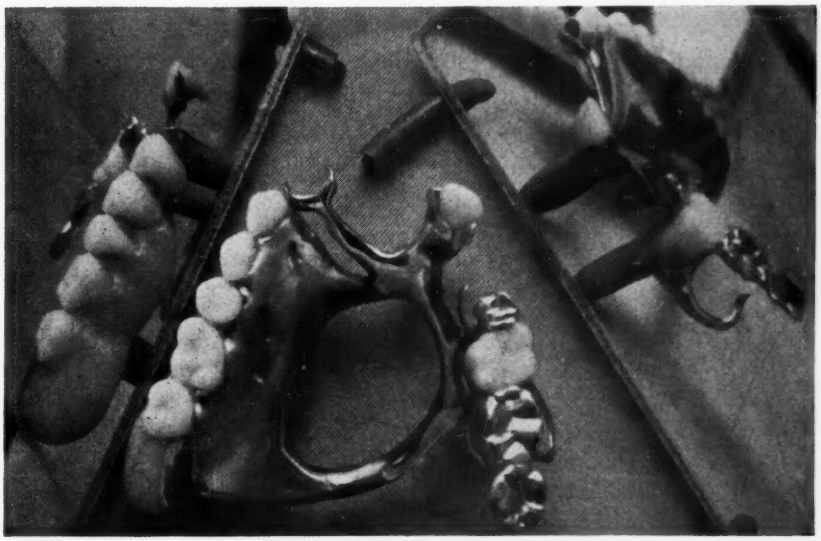


Fig. 13.

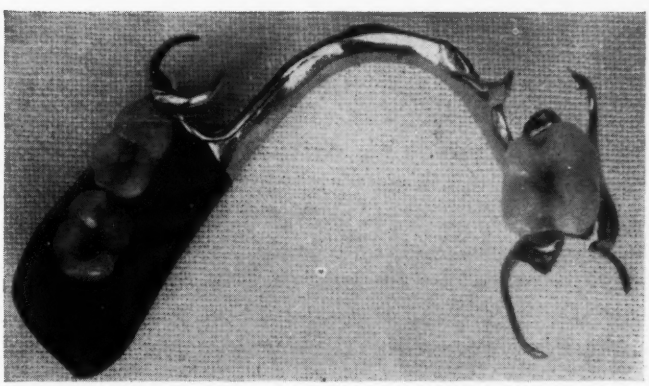


Fig. 14.

Figs. 13 and 14.—Class 1.2 (maxillary and mandibular dentures). In these dentures, the Class 1 design is completed as in Figs. 9 and 10, except that the retainer system must always provide for a retainer on the abutment(s) adjacent to the Class 2 saddle(s).

from the pressure on the saddle will be transmitted as nearly as possible along the long axis of the tooth, except on anterior teeth when the rest is placed on the lingual inclined plane to resist anterior stress during incision. If there are two or more saddles, they are joined by bars placed in appropriate positions and of sufficient strength to meet the requirements of each patient. The design is now

complete except for the placing of retainers* which are necessary, but nevertheless only auxiliary to the basic design. A selection of retainers is very much a matter of personal choice and, if the rules governing retention are observed, the selection of suitable retainers must be left to individual preference provided they perform the desired function (Figs. 9 and 10).

In Class 2 dentures, the bone and mucosa-covered fibrous tissue over the saddle area is the supporting medium. In these cases, the study of tissue support is the number one requirement. In addition to this, stress-breaking must receive consideration, because compared with teeth, the mucosa yields appreciably under the stress of mastication. Therefore, the first step is to design the saddles which must be as large as possible. When two saddles are required, they are joined by a bar rigid enough to keep the saddles in their proper functioning positions. The retainers are planned next quite separate from the saddles and the connecting bar. The final step is to connect the retainers to the denture proper by means of flexible links which will permit the saddles to move without overloading either the connecting link or teeth on which the retainers are placed (Figs. 11 and 12).

When designing a Class 1.2. denture, the Class 1 section is first planned, and its design is completed as above with the difference that a retainer must always be placed on the abutment next to the Class 2 saddle. Next, the Class 2 saddle is designed in accordance with the usual rules governing the coverage of the maximum area. The Class 1 and Class 2 portions of the denture are then joined by palatal or lingual bars as may be required. These bars must be so placed that the Class 2 saddle can function without overloading the abutment teeth. Therefore, the retainer on the abutment adjacent to the Class 2 saddle is connected to the denture at a point remote from the saddle in order to permit freedom for it to function on the resilient mucosa surface (Figs. 13 and 14).

SUMMARY

The primary consideration in partial denture construction is to distribute the forces on the occlusal surfaces with the minimum damage to the supporting tissues. This is accomplished with the aid of a detailed examination consisting of a clinical and roentgenopraphic examination, and an examination of study casts. The application of the data thus obtained leads automatically to a classification descriptive of the type of support each saddle permits. Class 1 saddles provide tooth support which gives trouble-free, comfortable service. Class 2 saddles and those Class 3 saddles treated as tissue borne provide fair to good support, but usually require relining at intervals of from two to four years in order to maintain efficiency. With the Class 3 or problem type of saddle, the result will depend in a very large measure upon the skill, knowledge, and experience which the operator can bring to bear upon the individual problem. If the operator has classified the saddles correctly, the prognosis of the vast majority of dentures is a foregone conclusion, and the design and construction can proceed with every confidence of a successful result.

No. 1 Creston, Aston Gardens
Bellevue Hill
Sydney, Australia

*The word "retainer" is preferred to the time honored but less accurate word "clasp."

THE ABC CLASSIFICATION OF PARTIAL DENTURE SEGMENTS

JOEL FRIEDMAN, D.D.S.

Brooklyn, N.Y.

THE PROBLEM

A HIGH order of similarity of conditions does not obtain in clinical dental research. Confusion in our prosthetic thought has been due in a large measure to an insufficiency of sound knowledge. Universal acceptance of facts forms the basic structure on which concepts are built, and there are not enough concrete facts to warrant many of the conclusions to which we subscribe. Paucity of facts leads us to the alternative search for "essential similarities" in the significant elements of a particular field. The potency of our correlations of these similarities imbues our findings with significance.

In partial denture prosthesis, many attempts have been made to organize the bewildering combinations of tooth arrangements into a comprehensible system. Most of these efforts have ended in cumbersome outlines which have been little understood and less remembered by the profession. The partial denture classifications have not been correlated adequately with problem analysis and with treatment planning. In consequence of this unrelated status, the classes and their subdivisions lack integration, and are not directly applicable to a pattern of case analysis.

THE MEANS

The procedure of classification should never be considered a goal in any scientific pursuit. It is a subjective procedure, an arbitrary and selective abstraction arrived at by relating similitudes from a mass of unorganized data. These generalizations have a limited scope which does not approach the ultimate aim of science—the formulation of a coherent, integrated system of laws. We can more easily see and discriminate things when we have given them names and symbols. A classification does not change the character of the things named, but it may be used as a means of relating the interdependent properties of a scientific domain. An outline can serve only as a framework, or plateau, where our impressions, beliefs, and findings can be correlated before we proceed anew in our search for objective truth.

THE PURPOSE

There is a stipulation in traditional logic which states that the value of a classification is determined by its success in achieving the intended purpose. A classification must be dynamic. It must provide the researcher in dental prosthesis with

Received for publication March 2, 1953.

an effective research instrument. The system propounded here aims at the selection of basic elements in the dental arch to bring a primitive order into the *identification* of missing segments and their relations. The common properties within the fundamental segment types can then be studied and evaluated to discern a few basic facts from which we may make a beginning towards a better understanding of partial denture prosthesis.

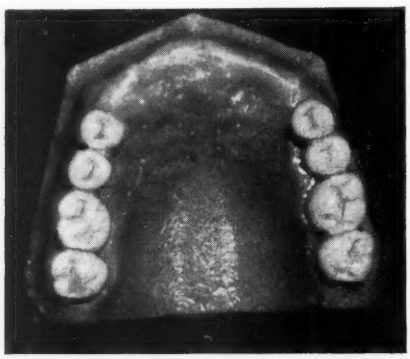


Fig. 1.—An anterior space *A*.

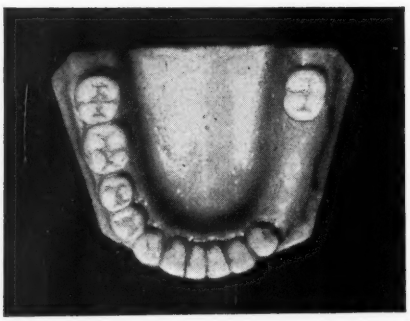


Fig. 2.—A bounded posterior space *B*.

CLASSIFICATION

It requires the discrimination of three essential segment types, occurring either as discrete or continuous segments, to classify any partial denture situation with relation to missing segments. *A*—Anterior space (Fig. 1), *B*—Bounded posterior space (Fig. 2). *C*—Cantilever (posterior free-end) space (Fig. 3). These segment types are drawn from the two *functional* segment areas, the incisive (anterior) and the masticatory (posterior).

A—Anterior Space.—The anterior space is a convenience grouping of the six anterior teeth in any combination:

1. Single missing anterior tooth. (Fig. 4.)

2. Two or more *continuous* missing anterior teeth (i.e., both central incisors, or a lateral incisor and its adjacent cuspid, up to the entire segment of six anterior teeth missing).

Two discrete or separate anterior spaces in the same segment (Fig. 5) are designated as such, and evaluated one at a time in the analysis of the case problems.

The common denominator of the anterior space is its participation in *incisive function.* Other attributes shared by anterior spaces are their incisive articular relations with respect to vertical and horizontal overlap, esthetics, phonetics, and their relative sites in the oral arch. The *Anterior Space* is designated by the letter *A.*

Fig. 3.

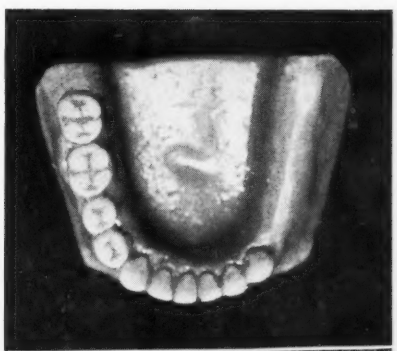


Fig. 4.

Fig. 3.—A cantilever (posterior free-end) space *C.*
Fig. 4.—*C-A-B* spaces.

THE POSTERIOR SPACES

The posterior segment comprises the *masticating* teeth posterior to the cuspid tooth, i.e., from the first bicuspid to the third molar. As a single functional unit, this segment receives the same masticatory stresses from its opposing arch regardless of the distribution of natural teeth and spaces within the segment. There is a highly significant variance in the action of a partial denture section when a posterior terminal abutment is present, compared to cantilever or free-end space action; therefore, each of the two is classed as a basic segment:

B—Bounded Posterior Space.—The bounded posterior space is composed of missing posterior teeth with one or more distal, or terminal, abutments: 1. A single missing bicuspid or molar bounded posteriorly by at least one natural tooth (See Fig. 4, left side*).

2. Two or more continuous missing posterior teeth bounded posteriorly by at least one terminal tooth. (Fig. 6, right side.)

Fig. 5.

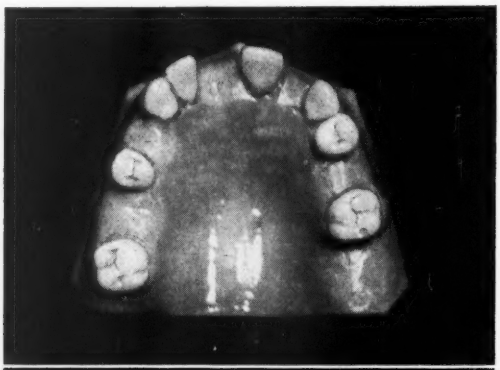


Fig. 6.

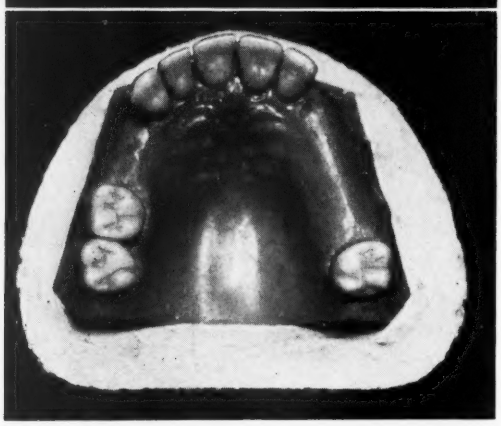


Fig. 5.—*B-B-A-A-B-C* spaces
Fig. 6.—*B-AB* spaces.

Two discrete spaces may be present unilaterally in this category. The first bicuspid and first molar may be missing, while the second bicuspid and one or two molars may be present distally. See Fig. 5, right side. These spaces must be studied separately before their requirements are integrated into the case analysis. The *Bounded Posterior Space* is designated by the letter *B*.

C—Cantilever (Posterior Free-End) Space.—This is a missing posterior segment having no natural tooth at its distal boundary. It terminates instead in an edentulous saddle area:

*Designations *left* and *right* refer to patient's left and right in all illustrations.

1. A single missing last molar. (See Fig. 4, right side.)

2. A continuous line of missing posterior teeth beginning with the two last molars missing (Fig. 7, left side), or a segment including all the molars plus the two bicuspids missing, all in a continuous line. There *cannot be more than one* free-end segment unilaterally.

The total masticatory stress applied to *B* and *C* by interaction with the opposing arch is identical. The division of classes is convenient because of the differences in the problems inherent in the groups and their relative capacity to resist and dissipate stresses. The magnitude of the supportive, retentive, stabilizing, and reciprocal problems as they derive from abutment relations varies considerably in the two segment types. The cantilever free-end posterior space is designated by the letter C.

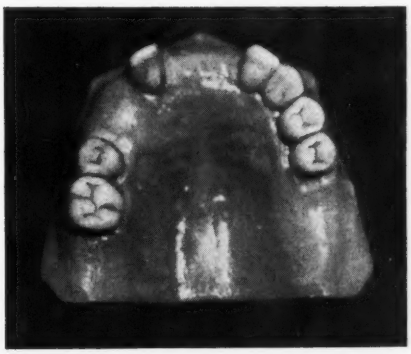


Fig. 7.—*C-BA-A-C* spaces.

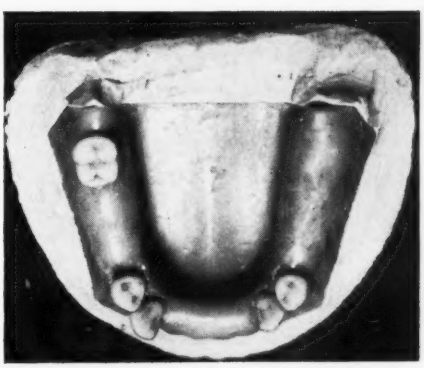


Fig. 8.—*B-A-C* spaces.

INCIDENCE OF BASIC SEGMENTS

The three-segment classification is adequate to describe the missing segments in any single arch. Spaces may be present as *discrete* units directly classifiable as an *A*, *B*, or *C* space.

Where discrete spaces are present, they are designated as follows:

1. An anterior space separate from a bounded posterior space *B-A** (Fig. 8, anterior and right side).

*For uniformity, all spaces are indicated from patient's right to left.

2. An anterior space separate from a cantilever space *A-C* (Fig. 8, anterior and left side).

3. Bilateral cantilever free-end saddles *C-C* (Fig. 9).

There may be a *continuous* space composed of two (rarely three) of the basic space types in combination:

1. An anterior space of one or more teeth may be continuous with a bounded posterior space. Its designation is *AB* (Fig. 6, left side) or *AB* (Fig. 10).

Fig. 9

Fig. 10

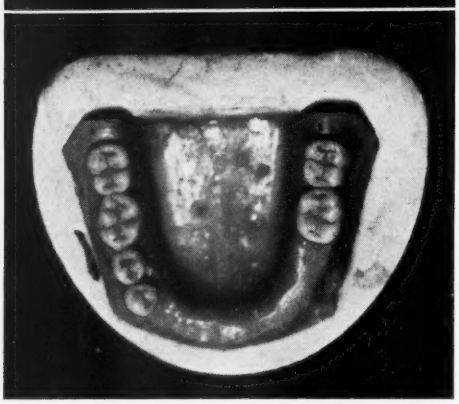


Fig. 9.—*C-C* spaces.
Fig. 10.—*AB* space.

2. An anterior space may be continuous with a cantilever free-end space (Fig. 11). Its designation would be *AC*. Omission of the dash separating the segments indicates continuity of the space.

3. *AB* and *AC* segmental problems both have special significance in that they "round the cuspid turn." They are combined anteroposterior segments. Arches which exhibit several large discrete spaces *B-A-C* (Fig. 8) are serious problems in reciprocation. *C-C*, the bilateral free-end space, and *BA-C* (Fig. 12) bounded posterior continuous with anterior space, and a discrete free-end space on the opposite side, are also in the category of difficult reciprocal problems. A *B* space is

never *continuous with* a *C* space, although both may be present in the same segment of the arch. (See Fig. 5, left side.)

MAGNITUDE

The variations discernible in spaces by examination of the individual study cast are in terms of magnitude of stress in the discrete (discontinuous) spaces. Magnitude of stress is directly proportional to the number of missing teeth, and to the

Fig. 11.

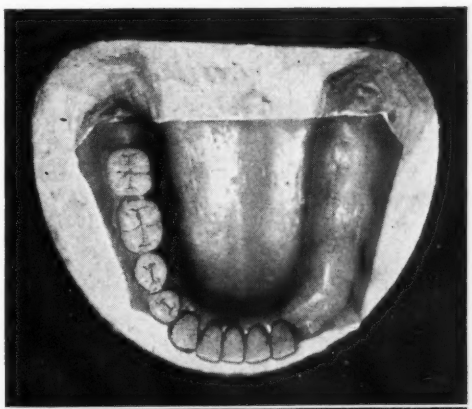


Fig. 12.

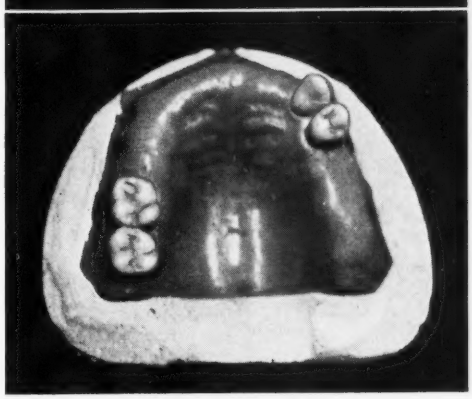


Fig. 11.—*AC* space.
Fig. 12.—*BA-C* spaces.

measurable length of the segment. Some other variables which exert direct influence on the magnitude of stress are occlusal relations, ridge relations, muscular chewing force of the individual, and habits.

A simple refinement to indicate the number of teeth requiring replacement is to make a numerical designate in the "upper fraction" or "root" position. To indicate a segment of three teeth to be replaced in an anterior space, use the symbol A^3.

For each segment, the number of teeth to be replaced varies from one tooth (Fig. 4, one tooth missing in each segment type) to the entire segment (Figs. 1, 2, and 3). Strictly speaking, the number of teeth missing, in itself, is not a reliable index of the length of the span, since a lower first molar frequently occupies the mesiodistal width of three lower incisors. A working approximation, at present for *length* of the missing segment is: short, medium, or long.

SUMMARY

At this point in the analytic procedure, recognition of the three basic segment types, notation of whether they are discrete from other missing segments or continuous, and an estimate of the length, is adequate. This minimum number of basic classes will permit adequate description of any partial denture situation. It is an approach to a *natural* classification, to a consideration of the functional essence of the elements classified. Its purpose is identical with the aim of all knowledge—to refine our expectations and make our predictions more reliable. By this means it may serve as a guide to research.

499 Lincoln Pl.
Brooklyn 38, N. Y.

SPLINTS IN MODERN DENTAL PRACTICE

With Special Reference to Oral Orthopedics

The Group for Orthopedic Research in Dentistry*

New York, N. Y.

SPLINTS in the mouth and around teeth are not new in dentistry. The ancient Egyptians used a crude form of wiring around teeth both for stabilization as well as for the replacement of missing members, with the wired teeth serving as abutments. In more recent years, maxillary and intermaxillary wiring and fixation have been used to stabilize jaw segments in fractures.

The more modern form of splints has progressed rapidly from the simple interdental ligation mentioned above. With the newer knowledge in orthodontics, periodontics, mouth rehabilitation, and now the more broadly encompassing oral orthopedics, the development of splints has shown remarkable advances in both design and materials, based on a broadened concept of the mechanical combined with the physiologic aspects. The profession owes a debt of gratitude to the research workers who have brought forth these new developments, and for the results of their studies in the basic sciences which embody the mechanical perfection made possible by the application of the advanced concepts.

Before we proceed with the discussion of the various types of splints, it would be well to develop a definition of splints to establish a basis for the evaluation of their purposes. Thus the discussion of types can become more meaningful in the light of the purposes for which they are designed.

A splint, as originally used in modern dental practice, was a structure or appliance intended to provide stabilization by joining two or more teeth to form a single unit so that masticatory stresses could be brought within the limits of physiologic tolerance. This obviously referred to splints used primarily during and as a part of periodontal treatment. As scientific advances have been made, this definition became broadened to include splints as part of the treatment in the orthopedic sense with the patient's total well-being and optimal health as the objective.

Oral orthopedics is concerned with jaw relations and the prevention or correction of improper jaw position. It is founded on the thesis that the stresses produced by jaw malposture are a common cause, not only of pain and other disturbances in the temporomandibular region and elsewhere in the head and neck, but also a major factor in periodontal breakdown. The objectives of oral orthopedic

Received for publication, Jan. 10, 1953.

*The group for Orthopedic Research in Dentistry consists of G. D. Kudler, D.D.S., R. Ritt, D.D.S., M. M. Lieb, D.D.S., A. A. Friend, D.D.S., J. E. Curry, D.M.D., and J. O. McCall, D.D.S.

procedures are to improve function, aid in the prevention or correction of periodontal disease, and to relieve the pain and other syndromes mentioned.

Splints, having the dual purpose indicated, periodontal or orthopedic or both, may range from the simplest ligation to the most complicated castings for stabilization of mobile teeth in the former, or for aiding in the correction of jaw malposture in the latter.

Under stabilization may be included the following specific purposes:

1. To immobilize groups of teeth to resist more effectively the forces exerted in static and dynamic functions of the jaws.
2. To prevent continued bone loss and gingival recession.
3. To carry forward the progress of periodontal treatment including elimination of periodontal pockets and occlusal equilibration.
4. To encourage the healing process with condensation of bone after the periodontal cause has been eliminated.
5. To assist in the realignment of teeth which have drifted because of periodontal disease.

Under orthopedic purposes are listed those which may be considered essentially orthodontic in nature but which in practice are utilized for orthopedic treatment, that is, repositioning of the mandible:

1. To stimulate eruption of posterior teeth.
2. To depress anterior teeth.
3. To aid in realignment of the mandible, correcting mandibular malposture.
4. To effect change in the position of the posterior segment of the mandible—either elevation or depression.
5. To realign the structures of the dental apparatus so as to effect correct function with minimum stress.
6. To correct the vertical dimension for improved mastication and esthetics.
7. To improve respiratory functions of the apparatus, i.e., breathing and speaking, and also the digestive function of deglutition.
8. To aid in eliminating mandibular malposture syndromes and other referred pains.
9. To permit correction of nonxious neuromuscular habit patterns (reeducation of the neuromusculature).

From the list of purposes noted above it may appear that our concern is directed primarily toward correction. From a true oral orthopedic viewpoint, the profession may well appreciate another list of purposes, less dramatic, certainly far less spectacular to the untrained mind, but nonetheless of even greater importance to the general public—prevention. Too many of us are accustomed to think of oral orthopedics as a corrective procedure, a method used to re-establish and recreate the architectural design devised by nature. The guidance of nature's plan toward the correct structural and postural alignment with optimal dental and general health through correct function has been a conversational topic rather than an actuality. Prevention has made rapid strides in the minds of men but not in the mouths and health of our patients comparable to the degree made possible by corrective procedures. Many of us still think of prevention as applying to children, but fail to recognize the long range objectives in prevention for adults.

We speak about adaptation and compensation of the body structures but fail to appreciate that the physiologic limits within which such compensation is possible in youth disappear with age, resulting in disease. In short, adaptation in youth through continued stresses results in disease in middle and advanced years.

Looking back upon some of the orthopedic purposes we find that rather than being content to correct mandibular malposture in the adult, we can and should prevent it in childhood and youth. In middle or advanced years, the corrective objectives of realignment actually becomes one of prevention of referred pains, continued stresses, and ultimate disease of the structures exposed to the need for accommodation.

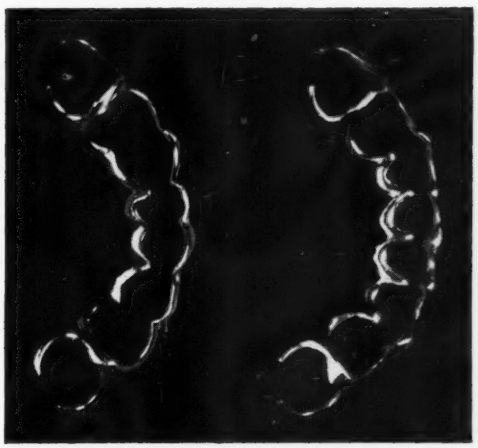


Fig 1.—Two forms of continuous clasp splint (steel casting). Note retention clasps and lugs, the lugs being required to prevent settling and consequent injury.

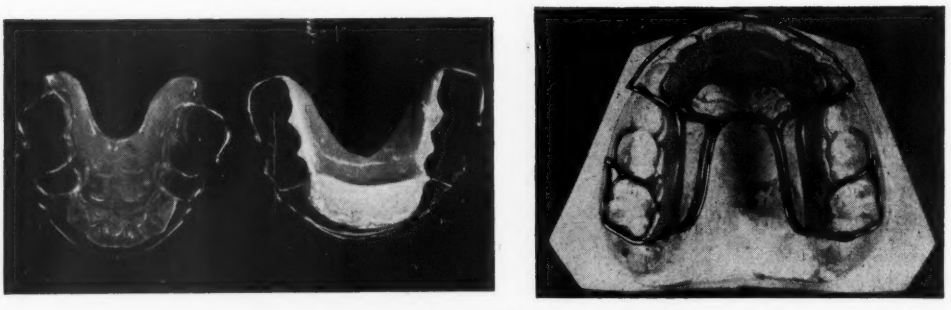
So we may have another classification—one of prevention—which can become a primary subdivision of the orthopedic purposes of splints:

1. To prevent malocclusion and malposture in early childhood
   (a) To minimize the influence of any inherited, predisposing factors which may result in the above.
   (b) To eliminate any early noxious habits, for example, thumb-sucking, abnormal tongue habits, etc.
2. To prevent excessive wear of the teeth and destruction of the supporting tissues (this obviously is a preventive purpose from a periodontal standpoint).
3. To prevent the development of local symptoms in and about the dental apparatus.
4. To prevent the development of changes in the postural relationship of other parts of the head, including the cervical spine and structures of neck.
5. To prevent the development of noxious neuromuscular habit patterns caused by mandibular malposture (by periodic examination of correct structural alignment to detect changes associated with abnormal masticating habits and other influences which may initiate unfavorable neurologic impulses to the activated muscles).

Certainly, the study of orthopedics and the use of splints in its application becomes more than a mechanical procedure; rather one which can more accurately be included under the term "applied dental medicine."

In our discussion of splints from the simplest to the more complicated, an overlapping of purposes may be noted in the use of a particular splint. This may now be more readily understood in the light of our over-all objectives, i.e., not simply mechanical but biomechanical and physiologic in addition to preventive.

There are, generally speaking, two types of splints—the removable and the fixed. As we discuss each example, its purposes in relation to these objectives will become more evident.



A. *B.*

Fig. 2.—*A* and *B*, Two forms of bite plate. These appliances provide stabilization for the upper anterior teeth and serve to depress the lower anterior teeth. At the same time they make possible the elevation of the posterior segment of the mandible and the further eruption of the posterior teeth.

REMOVABLE SPLINTS

1. The continuous clasp splint, a one-piece casting of cobalt steel or gold, may be used in any segment of the mouth for stabilization during the periodontal treatment (Fig. 1). This splint is designed as a loop around the lingual and labial or buccal surfaces with two clasps and definite lug rests on either side of the splint as a means of retention and stabilization. The advantage of this type is the ease it provides for the patient's home care, cooperation in toothbrushing, and gingival stimulation so essential as an adjunct to the periodontal treatment. The dentist is cautioned to provide for definite lug rests noted above, otherwise this appliance may act orthodontically if the tooth form, on the lingual especially, is not such as to prevent downward slipping of the loops. Also, this form of continuous loop may be combined with the lingual bar and free-end saddle removable appliance where anterior stabilization is a factor.

2. An upper bite plate may be used in periodontal treatment to stabilize the upper anterior teeth and also to depress the lower anterior teeth. When the retruded mandible is repositioned and a large posterior opening becomes evident, the bite plate may have the additional effect of stimulating sufficient muscular tension (supplemented by muscle exercises) to elevate the posterior segment of the mandible. Furthermore, this stimulation may also create the impetus for

further eruption of the posterior teeth. It is especially important when orthopedic correction is found necessary that the clinical crown shall not be of undue height after reconstruction.

The need for elevation of the posterior segment is frequently corroborated by the examination of the patient's lateral head and neck x-ray film in static occlusion. This film will often reveal a downward tilt of the posterior segment in relation to the anterior and to the horizontal plane.

Fig. 3A.

Fig. 3B.

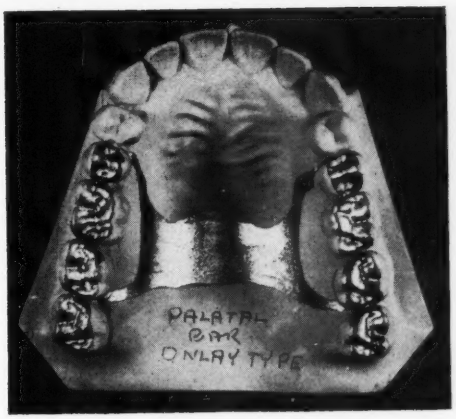


Fig. 4.

Figs. 3 and 4.—Lingual or palatal bar appliance with onlays covering the occlusal surfaces of the posterior teeth. The appliance may also cover the incisal edges of the anterior teeth.

Where these unit onlays are made without a lingual or palatal bar, they may be converted into fixed splints—acrylic veneer cast metal cusp type—by adding fast curing acrylic after the preparation of the individual teeth. The buccal arms serve as retentions for the acrylic buccolingually.

Bite plates may be constructed in one of two ways: the Hawley all-acrylic horseshoe and the Jackson palatal bar appliance (Figs. 2,*A* and 2,*B*). Both have flat planes on the palatal surfaces from cuspid to cuspid area. Indentations on this plane may be used as definite reference points for the lower anterior teeth in cases which present difficulty from the neuromuscular aspect. However, these indentations should be filled in or polished to create flat surfaces as soon as possible to give the mandible freedom to find its position of physiologic advantage. Inclined planes with or without indentations may be used in cases of extreme muscular

tensions requiring forward correction through repositioning. Again, these planes should be leveled as soon as possible.

Eruption and segmental elevation should be observed carefully by repeated clinical examinations and lateral neck radiographs to avoid development of an open space between the anterior teeth.

3. The lingual or palatal bar appliance with onlays covering the occlusal surfaces of posterior teeth, and sometimes even the incisal edges of anterior teeth

Fig. 5.—Lateral head and neck roentgenogram in a case of jaw malposture featured by retrusion of the mandible. (Courtesy *Dental Digest*).

where necessary, is another type of removable splint (Figs. 3, *A* and 3, *B*, and Fig. 4). The onlays may, of course, be either acrylic or metal, depending upon several factors:

(a) *Particular purpose:* Here we refer to the patient who presents syndromes related to malposture disturbances necessitating the immediate construction of acrylic onlays for relief of discomfort. While these splints have the advantage of rapidity of fabrication, the fragility of the acrylic material obviously indicates the frequently occurring need for repair due to wear and breakage.

(b) *Age and health of patient:* These are significant and in cases where they are factors, removable splints may obviate the necessity for the construction and insertion of fixed splints and subsequent final reconstruction by fixation. Patients experiencing the menopause, with their extreme apprehensions often encountered, cardiacs, and others may be included under this classification. The correction of malposture may therefore be completed with the use of the removable appliance

and the more durable metal onlays. The major disadvantage (accruing from either acrylic or metal onlays) is the potential increase in the caries incidence. More frequent re-examinations, application of silver nitrate and formalin to the contacted surfaces, and other measures may be of assistance in the control of this disease. Another disadvantage is that physiologic fixation of mobile teeth is not possible with this type of appliance.

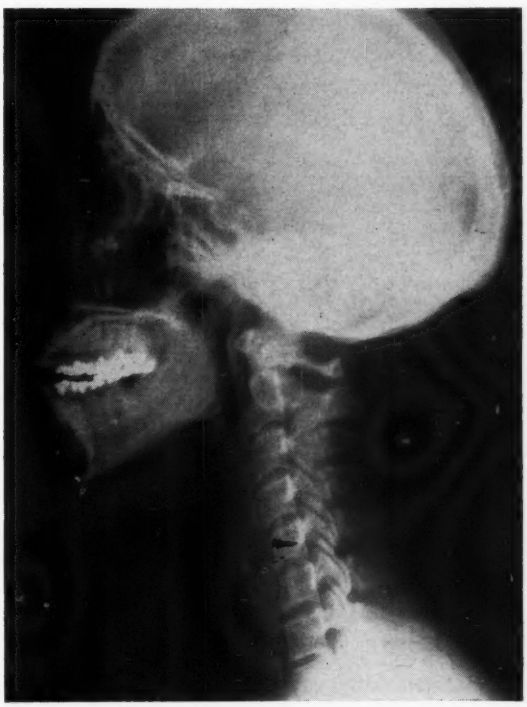


Fig. 6.—Same case as shown in Fig. 5. The mandible has been temporarily brought forward to the desired extent. This view demonstrates the elevation of the posterior segment of the mandible caused by the early loss of posterior teeth and the accompanying retrusion. A removable appliance (to depress the segment) in conjunction with muscle exercise is needed to correct this malalignment. (Courtesy *Dental Digest*).

Convertible removable splints.—

Removable onlay splints on lower or upper posterior teeth may be converted into stationary splints as follows:

Unilateral metal onlay splints with arrangement of clasps, as shown in Figs. 3,*A* and 3,*B*, are constructed as one-piece castings. Any marked lingual contours or undercuts should be relieved. These splints may be cemented into position and thus the occlusal pattern correction is achieved and maintained. Preparation of teeth thus treated may be completed individually or in pairs (with splint removed). Fast curing acrylic is placed into the areas prepared and the entire splint is seated and as the acrylic is curing the buccal wall is adapted. The clasps serve as grips for the buccal surface acrylic. After completion of curing the splint is removed, the acrylic is reshaped and polished and the splint cemented into position with a sedative cement protecting the prepared teeth. After all the teeth in

each area have been prepared, and the process of adding acrylic repeated, the result is a stationary splint consisting of cast gold cusp-acrylic veneer crowns.

(c) *Certain types of mandibular malposture:* Where the posterior segment of the mandible has been elevated in the course of progressive retrusion, the removable appliance is definitely indicated to depress and thus realign it to correct posture. Such an appliance, usually made with acrylic onlays, would create contact only on the posterior teeth, leaving the anterior teeth in an open position. Biting exercises on the anteriors then will create sufficient stress to depress the posterior and raise the anterior segments. Lateral head and neck radiographs are of definite diagnostic aid in demonstrating the need for tilting the mandible downward in the posterior area (Figs. 5 and 6).

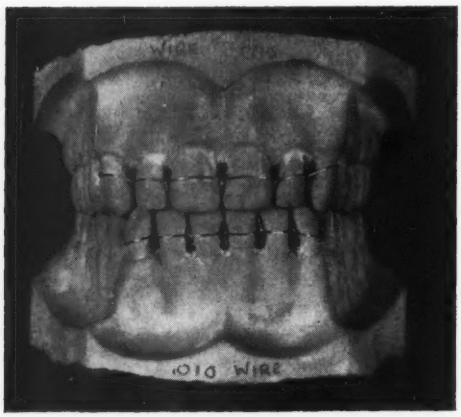


Fig. 7.

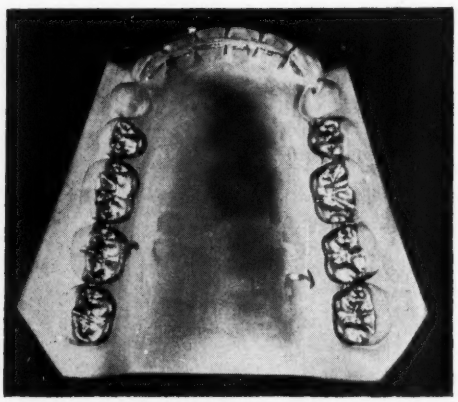


Fig. 8.

Fig. 7.—Interdental (steel) wire ligation, used for temporary or stabilization in the course of periodontic or orthodontic treatment.

Fig. 8.—Combination twisted wire and acrylic splint for stabilization of the lower anterior teeth. This type is semipermanent. This splint is fabricated directly in the mouth. A similar splint may be used on the upper anterior, also on the posterior teeth. Note fixed onlay type splints on the lower posterior teeth.

STATIONARY SPLINTS

The stationary splint, as the name implies, is one of fixation, creating a single unit of two or more teeth:

(a) *Interdental wire ligation:* This is used for stabilization, during and after periodontal treatment, and frequently as a retaining mechanism after orthodontic treatment (Fig. 7). A main arch consisting of a double strand of 0.010 gauge stainless steel wire with single strands of 0.010 gauge for interdental wires is the usual combination.

(b) *Intradental or internal dental splints:* These require preparation within the tooth and are used primarily for stabilization.

(1) *Anterior wire acrylic type:* Lingual surfaces of upper or lower anteriors are prepared with knife-edge stone to the dentine, followed by an undercutting stone. A spiral twisted wire is fitted in a sine curve arrangement from tooth to tooth. It is held in position while fast curing acrylic with brush method

fills in remainder of the preparaton (Fig. 8). Polishing and contouring follow the hardening process. The spiral wire should be heat treated to eliminate any tension.

(2) *Occlusal wire acrylic type for posterior teeth:* This is the same as above, applied to the occlusal surfaces of posterior teeth. Both are executed directly in the mouth. The teeth at either end should have a mesial and distal undercut, respectively to permit the locking of the wire.

(3) *Indirect occlusal acrylic splint for posterior teeth:* A box preparation of sufficient width is made on the posterior teeth but firm buccal and lingual walls are retained. A good impression is made for sharp detail. Casts are poured and articulated, and an acrylic splint reinforced by firm wire is constructed on the cast.

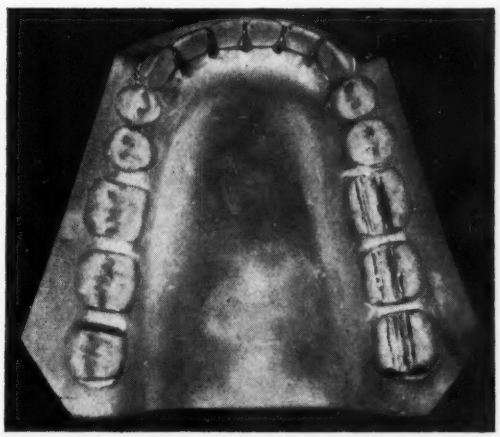
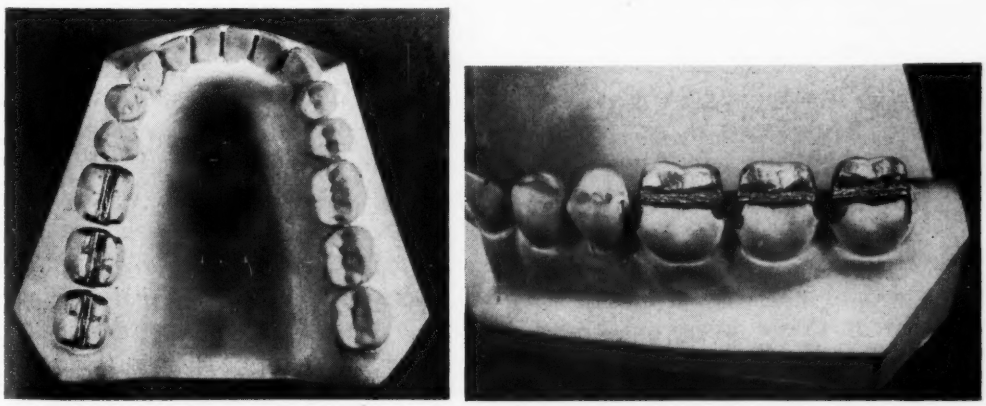


Fig. 9.—Right side. This is a variation of the type of preparation used for the twisted wire acrylic splint. The walls of the preparation are more divergent to facilitate construction of gold castings. The casting is made in the form of a trough with retention for acrylic, thus providing for esthetics. Note lingual view of interdental wire ligature splint shown in Fig. 7.



A. *B.*

Fig. 10.—*A*, Left side. Preparations for onlay type of splint with interproximal slices. No occlusal grinding is done since the cusps will be shod and the splint used to increase vertical height. *B*, Side view. This is to be an all-cast gold splint, with proximal walls included and cusps shod. Acrylic inserts may be used for esthetics.

Immediately prior to cementation, undercuts are made at the cavo-line angles and the splint is cemented with acrylic cement.

(4) *Cast base occlusal acrylic splint:* The preparation is made with slightly divergent walls with a slight bevel on the enamel. The impression and casts are made as in No. 3, and a gold trough is cast, lining all the preparations (Fig. 9). This trough has retentions for the acrylic, which is processed in the gold trough, the splint being cemented like an inlay. Where the effectiveness of retention is questioned, a groove may be made at both ends with a No. 701 bur.

Where interproximal contacts are high toward occlusal surfaces, and future caries is anticipated, proximal slices may be made (Figs. 10, *A* and 10, *B*). (See also Fig. 9.) The preparation and casting of the occlusal trough therefore includes proximal walls as well as the occlusal boxing.

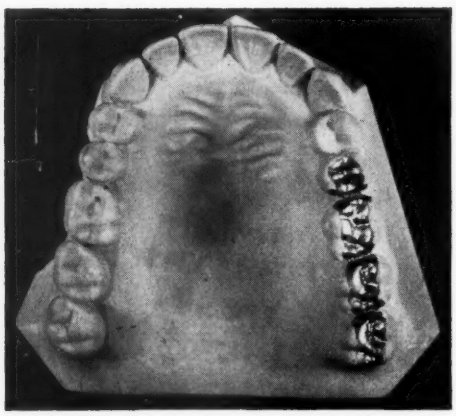


Fig. 11.—Preparation for the type of case in which caries in not a problem. Joined MOD onlays with simple proximal slices provide a suitable splint. To be used where full coverage is not needed. Note minimum preparation.

Where occlusal adjustment or mandibular repositioning is indicated, the cusps of the teeth may be shod and gold cusps created on the splint in addition to the above. By this method correct levels for occlusal equilibration may be effected in the splint with or without increasing the vertical dimension or repositioning the mandible.

(c) *Onlay and overlay splints (complete stationary splints in preparation for final reconstruction procedures):* These are splints, which, as the name implies, are placed over and on tooth preparations. The term *preparation* is relative, ranging from simple interproximal slicing (without occlusal grinding except for sharp cusp points) to the more complete tooth reshaping for complete coverage. The design of the splint in terms of the amount of tooth coverage depends upon (1) existence, extent and incidence of caries in the individual mouth, (2) extent of involvement of existing restorations, (3) esthetics, (4) position of teeth, (5) degree of change in vertical height of jaw position, (6) condition of musculature, and (7) potential capacity of patient for neuromuscular reeducation.

It is interesting to note at this point that the trend in fixation procedures as well as in stationary bridgework is toward full coverage as a preventive of future caries in addition to its place in corrective service. However, when little or no caries exists, and splinting is indicated as the first stage in reconstruction and repositioning, the onlay type with simple interproximal slices may be the proper choice. The splint is a one piece metal casting of cusps with interproximal metal walls (Fig. 11).

The full coverage splint may be one of the following (note the advantages and disadvantages in order properly to appraise the indication for each):

1. The all-acrylic splint is excellent as a temporary bridge during the construction of the final castings and pontics in cases in which bridgework does not involve marked changes in the occlusal pattern of the mouth (Fig. 12). Limited to a specific segment, it is functional, preventing shifting of teeth and eliminating the need for repeated changes of individual temporary crowns. It requires partial tooth preparation and also permits of periodontal treatment during the construction

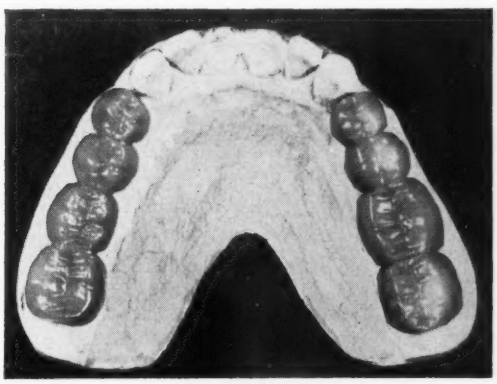


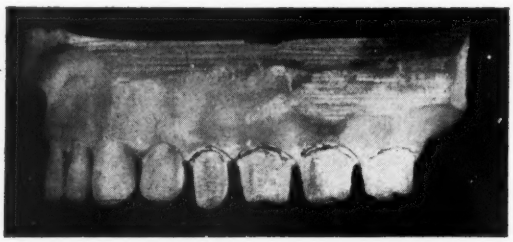
Fig. 12.—Case requiring full coverage in which it is desired to provide a splint as a temporary measure. An all-acrylic splint is made and set with sedative temporary cement. As this is subject to wear it must be replaced as soon as possible with a permanent splint.

of the finished appliance rather than after final insertion. As a splint for more extensive reconstruction and for jaw repositioning, this type has the following disadvantages: (a) Occlusal wear of the acrylic precludes its use for an extended period. (b) Elasticity and spring of the acrylic covering leads to loosening of splint, seepage and gingival damage, and conceivably destruction of tooth structure by caries. (c) Fragility of the material renders it liable to fracture, with need for numerous repairs.

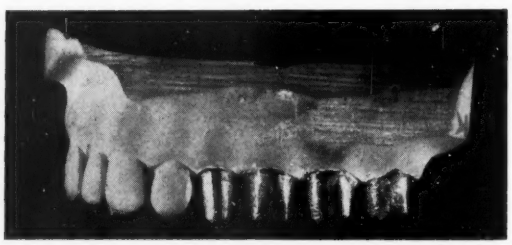
2. To overcome some of the above disadvantages, the combination of cast metal copings with occlusal stops may be used. Where the time interval between the construction of the initial splint and the final reconstruction is not too protracted, swedged metal bands, sweated or welded, covered by acrylic, may be employed. Of course here, too, the occlusal wear with consequent change in vertical height and jaw relationship presents a definite problem more readily eliminated by the cast coping with occlusal stops.

The preparation of the teeth presents some interesting facets in procedure. The simplest method where there are no malposture symptoms is to prepare one or more

teeth at a sitting under anesthesia, make individual band impressions, construct individual gold cast copings with occlusal stops (the number depending upon the cusps of tooth), and cover each preparation with a crown suitable to maintain the existing occlusal height (Figs. 13,*A* and 13,*B*). A sedative cement dressing is obviously used under these coverings for patient comfort. These cast copings are the finished copings constructed with the occlusal stops to be needed for the splints.



A.



B.

Fig. 13.—*A*, Buccal view of preparation of teeth to receive cast gold copings. *B*, The copings are made with occlusal stops to maintain the desired occlusal height. The crowns will be completed with acrylic for esthetics.

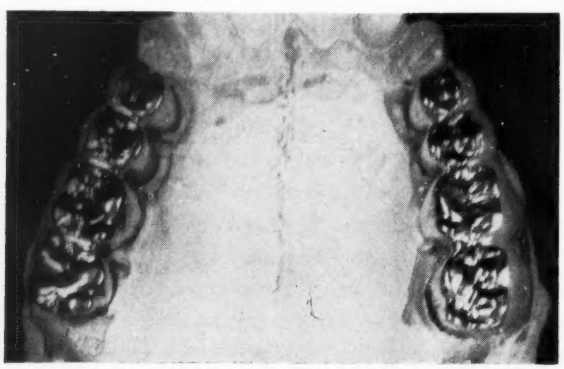


Fig. 14.—Occlusal view of cast gold and acrylic splints in a case where the splint must be worn for some time. It is not made as a permanent splint at this stage as provision must be made for possible extension of the preparations if further gingival recession takes place during the active phase of repositioning.

The height of the occlusal stops can be leveled off more accurately after assemblage of all those involved, and casts are articulated on an instrument suitable for the particular need of the case—i.e., repositioning, increasing vertical dimension, etc. From this point, the splints may be constructed in one step with the proper shade of acrylic cured over the copings or bands.

3. In those cases where the splints are to be retained for a considerable period of time, particularly in the light of the need for neuromuscular re-education, the all-metal cast splint or the combination of metal and acrylic is definitely preferable. Here, the definite occlusal pattern—giving the patient needed reference points— remains almost intact; the jaw level and relationship once established may be maintained with little fear of occlusal wear or change. In these cases, the preparations must approach the picture of completeness for well-fitted castings (Fig. 14). This type of appliance bears a close resemblance to the completed construction, and the question may therefore arise, "Why repeat the entire casting procedure?" The answer is that, from a clinical standpoint, some gingival recession usually occurs in this primary stage, necessitating further extension of the preparation gingivally later for more precise rehabilitation. Secondly, it is difficult to determine beforehand the initial response of the patient as to the alteration of the old muscle habit pattern (despite preparatory and other muscle exercises). Even slightly uneven wear may defeat the ultimate objective. Changes of several types therefore may be required in the initial splint, which at the final step should actually be the pattern for the completed reconstruction. In this type, also, cementation is done with a sedative cement for easy removal for examination of the tissues, extent of recession, etc., while the case is under way.

CONCLUSION

Splints form an essential tool in modern dental practice. They may be used for temporary or permanent stabilization of teeth, offering in many cases needed mutual support of teeth for withstanding stress. From the broad concept of oral orthopedics, splints may be the means of eliminating pain syndromes in the head and neck and aiding in the treatment of periodontal disease, as well as supplying reference points for the teeth in the new relations and support during neuromuscular re-education. Several types of both temporary and permanent have been described and illustrated.

Grateful acknowledgement is made to Dr. M. Turoff for preparing photographic prints for the illustrations used in this article.

REFERENCE

The Group for Orthopedic Research in Dentistry: Oral Orthopedics, Its Nature, Significance and Application, D. Digest **58**:386-94, 1952.

30 West 74th St.
New York 23, N. Y.

VENTS AND CUPS FOR CENTRIFUGAL CASTING

CLARENCE H. BLANCHARD, B.S., D.D.S.

Los Angeles, Calif.

IT IS THOUGHT that compression of air trapped ahead of molten gold during the filling of a mold is a cause of defective castings. This concept is fortified in practice by observations made on gold castings formed when vacuum is applied simultaneously with pressure or centrifugal force so that the melted gold encounters no back pressure when entering the mold. Castings so made tend to have strength with a favorable grain pattern.

Vacuum methods can be approximated by providing free egress for internal air through exit channels leading to the outside at some point on the exterior surface of the mold near the crater, but where the channel's exterior orifice cannot be covered by the advancing melted gold or button (Fig. 1).

By this means, back pressure is avoided and density in the mold material ceases to retard escaping gases. The melted gold can enter the mold freely as though it were moving in an open atmosphere.

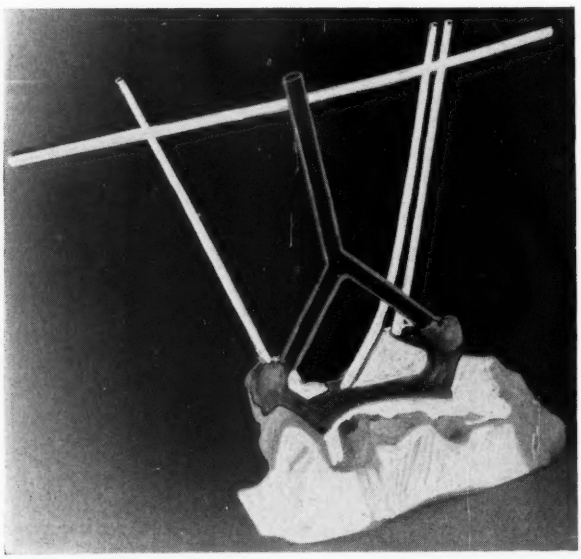


Fig. 1.—A sprue and vent system erected ready for investing. Here an extra vent has been attached at the center of the lingual bar because gold entering simultaneously from each side will push mold gases toward this point. The top cross piece is a support for the system of vent fibers which is attached to the sprue.

Received for publication Dec. 19, 1952.

The location of the exit points is important. One placed immediately adjacent to each sprue is usually adequate when the sprue is attached at the nearest level of the wax pattern (Fig. 2). In this case the entering gold flows first by gravity or centrifugal force to the farthest part of the cavity, then backs up toward the

Fig. 2.—A vent former attached between an inlay pattern and the crater rim.

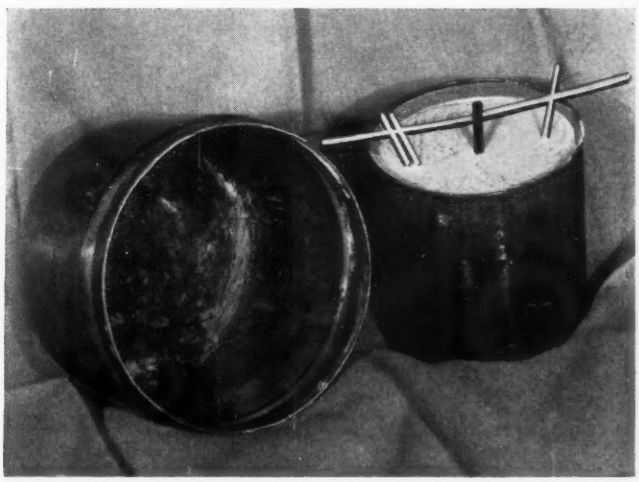


Fig. 3.—The vents and sprue protrude from the investment. The vents will be pulled or burned away. A crater will be formed by hand, carving at a safe distance from vent channels. The surface of the investment is kept a little below the edge of the ring or cup so that surging gold will not spill if it fails to return into the crater.

point of entry. When the sprue and exit for air are contiguous, air escapes as fast as it is displaced by gold until the mold is filled. If the exit were farther away, some air would be trapped and back pressure built up. There is another reason for keeping the two together. When the gold surges into the mold, momentum carries it into the escape channels so that some metal flows back outside where

it should be channelled into the crater again. In this case, if the sprue is too small, or too far away from the vent with a bottleneck, or too small channel between, some of the melted gold may drain away and not be replaced adequately. This would cause voids or weak grain structure. This is a fault that is easy to avoid.

The material for the exit channels may be wax, string, broom straws, etc. A convenient plan is to keep a plastic-fibered whisk broom by the waxing bench. Straws from it can be used as vent formers. These are pulled from the investment later, or burned away in the oven. When a bend in the vent-former is desired, as in Figs. 1 or 2, the plastic straw can be heated at the edge of a bunsen flame for shaping.

When the sprues are attached at a distant point, they must be adequate in size, and exit channels should start at the highest level of the pattern (relative to the button) for that is the last part of the cavity to fill. The idea is to make an escape-way for mold gases at any place where they would be trapped otherwise or forced to dissipate via pores in the investment.

Another help is the use of cups to hold the mold (Fig. 3). When a mold contained in an open-ended ring cracks, the melted gold often sprays away. To prevent this loss, the bottom of a cup can be used to catch the gold so it may be used again. An asbestos lining placed in the cup before investing covers the bottom so that spilled precious metal is kept from contamination by contact with base metal of the cup. The author describes this cup idea with some fervor, since his centrifugal casting machine sits by an open window and the street outside acquired a paving of gold in pre-cup days; Heavenly by description only.

Cups are not needed for small masses of investment used to form inlays. The danger of mold breakage exists practically only in larger partial and full denture work. Cups for this purpose are not a stock item but must be "scrounged" here or there. The largest size the author uses was a developing tank intended to hold 35 mm. film. Another cup was a vessel found in a surgical supply house, while the smallest was a metal creamer seen in a restaurant supply dealer's stock. All are stainless steel, and were trimmed to a suitable height before use. Tin cans will do as well, if they have crimped joints, but would be less durable.

These pointers are applicable to centrifugal casting only.

617 South Olive Street
Los Angeles, Calif.

ELIMINATION OF WAX BY VACUUM FOR PARTIAL DENTURE CASTING

E. D. SHOOSHAN, D.D.S.

Pasadena, Calif.

THE USUAL method of eliminating wax from a refractory mold used for casting a partial denture is to carbonize it in a furnace. One of the disadvantages of this method is that the surface of any investment subjected to prolonged or high heat will break down and result in a rough casting. The carbonization technique also has the disadvantage of creating unpleasant odors in the office.

The removal of wax by vacuum permits the use of a low furnace temperature since carbonization of wax is unnecessary. It is presupposed that the technician will compensate for the shrinkage of gold by utilizing hygroscopic setting expansion together with thermal expansion of the investment.

TECHNIQUE

The pattern is invested in the refractory investment in a casting flask. The flask is placed in boiling hot water with the sprues up, after the investment has set. When the wax softens and begins to float out of the sprue holes, the casting flask is removed from the water. It is placed over a piece of gauze or absorbent paper with the sprues down, and a vacuum is applied. The vacuum will withdraw the softened wax with water and vapor from the investment.

The process should be repeated two or three times depending upon the amount of wax in the mold. That is, for large masses of wax, it is placed back into the hot water until the new wax again begins to float from the sprue holes. Then the vacuum is applied as before. The mold can be made practically free from wax and with very little residue remaining.

The casting flask is then placed in the furnace with the sprue holes down. The cycle of thermal expansion is completed and the mold is dried out and heated for casting. The furnace temperatures are not given here, in as much as they should be chosen according to the water-powder ratio used in making the refractory mold and cast. However, the author has made many castings with the furnace temperature held at 700 to 800° C. for approximately two hours. If the freshly mixed investment has a sufficiently thick consistency, there will be adequate compensation for the shrinkage of gold. It is imperative that the powder-water ratio for both the refractory cast and the outer investment be the same, and that they be mixed from the same kind of investment. In every instance they must have identical coefficients of expansion to avoid an opening between them. Such a space would cause feathering of the gold where it would flow between the different mixes of the refractory material.

70 NORTH EL MOLINO AVE.
PASADENA 4, CALIF.

Received for publication Feb. 25, 1953.

HOW WE CAN IMPROVE OUR OPERATIVE DENTISTRY

RUSSELL W. BASSETT, D.D.S.

Beverly Hills, Calif.

IT HAS BEEN my pleasure for some time to have lunch each day with two or three good dental friends. As we sit down to eat and discuss dentistry, the opening remark is usually, "Well, Joe, what's new in grief?"

Every one of us is striving to get an answer to our problems, some solution which will prevent trouble in the future. In order to improve one must first recognize a need for improvement. As we discuss our "grief cases" or failures (and we all have them) it is always helpful to retrace our steps and again study and analyze the fundamentals involved searching for a violation. There is nothing so disconcerting as to have trouble, and not know the cause of it. Once the cause is found, we can do something about it. Our thinking must be analytical, done with an open mind, and with a real desire for improvement.

Operative dentistry is a big part of general dentistry. It has to do with all the surgical procedures in the teeth as well as their restoration.

The health of the investing tissues should be included too. Is there any phase of dental treatment that is more neglected? Any oral surgeon will tell you that more teeth are lost as a result of periodontal lesions than from caries. Who is to be responsible for this condition? We general dentists must assume this responsibility if we are to improve this deplorable condition. I know we have periodontists, and hygienists. The periodontist usually gets the case in its most advanced stage and is then expected to do miracles. The hygienists are doing what they can, but are lacking in numbers, and some dentists do not carefully supervise their work. If we are to reduce the number of teeth lost by disease of the investing tissues, we must make an early diagnosis and do our prophylactic work regularly and carefully.

Prophylactic work is not very interesting, and it can be discouraging to clean up a mouth only to find it six months later in a filthy condition again. The most difficult part of this work is to teach daily oral hygiene habits. Yet if we as general dentists do not try, and keep trying, to correct these problems, we are not well-balanced dentists. How many times do we see a sincere effort in restorative dentistry failing because of soft tissues swollen and inflamed, alveolar bone lost, and the roots loaded with serumal deposits? If we do not care to do this work personally, it is still our job as operative dentists to see that this preventive part of dentistry is done thoroughly by someone and carefully supervised.

Read before the First District Dental Society in Los Angeles, Calif., Feb. 18, 1952.
Reprinted from the Southern California State Dental Association Journal, October, 1952.

Any concept of restorative dentistry should be complete. It should start with diagnosis and end with the finished product functioning in the mouth. If we think of operative dentistry in this manner, consider the fundamentals involved, and how to achieve them, then our operative dentistry should be improved. The restoration of lost tooth structure with cast gold has been selected for our example.

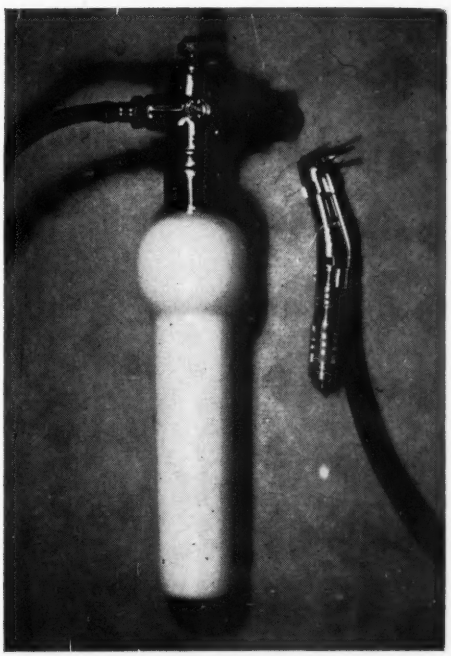


Fig. 1

Many of our failures can be traced directly to faulty diagnosis. It has been said many times that all good dental treatment should be based on thorough diagnosis. Before any tooth in the mouth is operated on, the dentist should have a complete set of apical and bite-wing x-rays. Study casts made from accurate impressions are also invaluable.

In the x-rays will be noted:

1. Size of the pulp and pulp abnormalities.
2. Amount of caries present.
3. Condition of the alveolar bone.
4. Presence or absence of serumal deposits.
5. Length of the roots.
6. Presence or absence of infection.

Through clinical and visual examination the following may be noted:

1. Vitality.
2. Occlusion.
3. Length of crown.

4. Amount of retention required for the purpose the casting is to serve.
5. A visualization of the finished restoration, with its preparation, outline form, and interior detail of the cavity prior to preparation.
6. Proper selection of filling material to be used.

CAVITY PREPARATION

Many years ago "The Grand Old Man of Dentistry," Dr. G. V. Black, laid down the fundamental principles of cavity preparation, and these, with few modifications, hold true today.

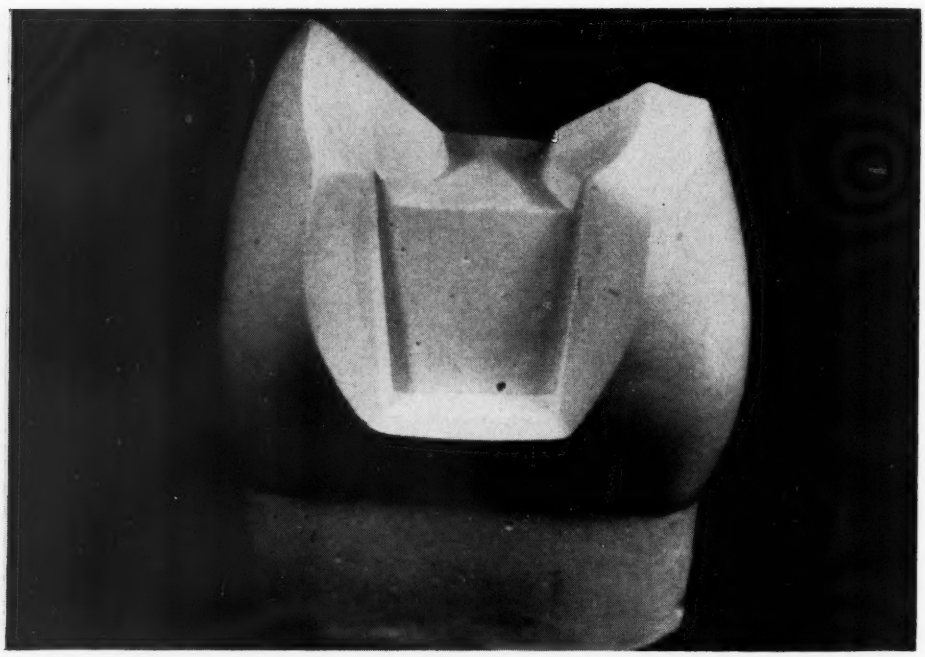


Fig. 2.

In cavity preparation, care should be taken at all times to avoid heat. The possibility of over-heating a tooth, using diamond and carbide burs, is greater today than ever before. I am sure that we all recognize the possibility of injury to the pulp. Teeth may be kept efficiently cool by use of a mixture of air and water in the therm-x-spray, or by a stream of water directed by our dental assistant (Fig. 1). When water is used it will be found that burs and stones cut much better and without clogging, and cavities will be relatively clean when finished.

Slight undercuts in the internal part of the cavity may be compensated for in waxing procedures, but there is no way to compensate for an axial undercut. It is helpful to establish axial margins by use of the wet-o-dry discs. The gingival margins are finished with a sharp gingival margin trimmer. The axial and gingival margins should definitely connect in a graceful curve (Fig. 2).

It is impossible to make an inlay fit accurately in a cavity with axial undercuts. The casting will flare away, at the axial-gingival angles, a common cause for failure.

We are aware that some inlays fail due to faulty gingival margins. To correct this fault we must have definite gingival bevels, something definite to work to. Many castings fail on the occlusal margins. This may be due to improper occlusal bevels, leaving loose enamel rods in this area. When the occlusion is heavy, and there are definite facets of wear, the cusps should be capped, including those facets. When facets of wear are covered, the bevels should extend slightly beyond the facets to avoid direct occlusal pressures on these margins, causing failure. When cusps are capped it is essential to have enough thickness of gold to withstand the forces of mastication (Fig. 3). It has been my policy routinely to cap the distolingual cusps in D.O. preparations in upper molars, and the distobuccal cusps of lower molars, requiring D.O. or M.O.D. preparations.

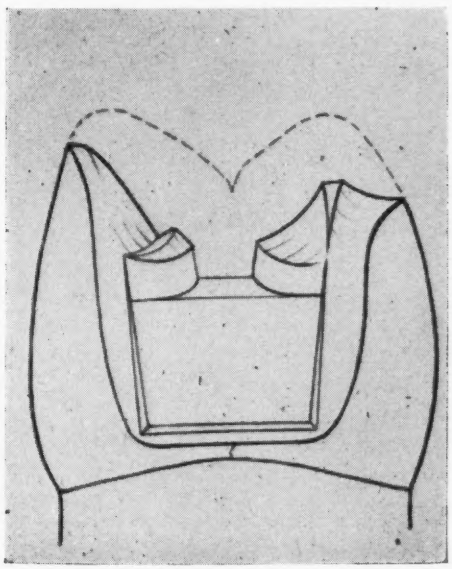


Fig. 3.

Members of Gold Foil Study Clubs, realize the value of this training, not only in foil work, but in all operative procedures. In study club work we learned to use well designed cutting instruments, and how to keep them sharp. Stress was placed on good vision, and what to look for. We were taught to plane and finish our margins carefully, always removing all loose enamel rods. There are many such steps in the construction of a gold inlay restoration, none of them more important than the other, but some more difficult to master. Cavity preparation is one of the more difficult steps (Fig. 4).

I am glad to see the postgraduate courses offered in cavity preparation. It tells me that we are going back to fundamentals, in an effort to improve our dentistry. Once one is trained to visualize the finished product before operating, and the technique involved, the easier the task becomes.

IMPRESSIONS USING AGAR HYDROCOLLOID

The use of agar hydrocolloid to reproduce the teeth and their preparations has been one of the greatest boons to better dentistry. Because of the extreme accuracy of agar hydrocolloid it has disclosed many of the causes of failures. On the casts we are able to see faulty margins, and margins which are failing because of occlusion. Facets-of-wear stand out boldly, asking to be protected by the proper capping of cusps. We can see so much more on our stone die than we can in the mouth, and have a great opportunity to study cavity design and detail. With a self-critical open mind, we are in a position to improve our dentistry.

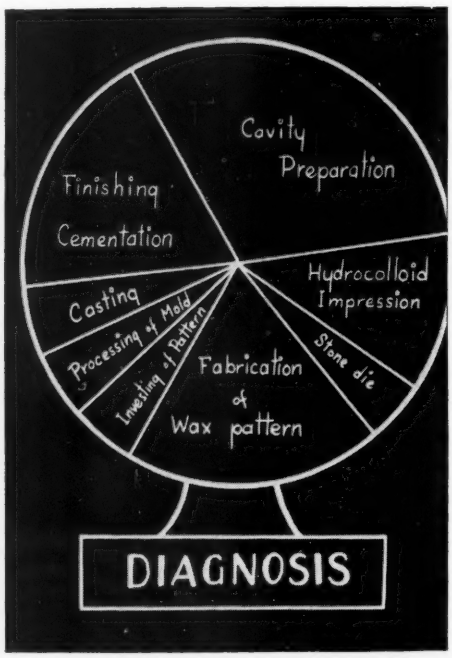


Fig. 4.

The use of hydrocolloid offers the following advantages:

1. It permits us to study failures, (ours and other's).
2. Accuracy of reproduction.
3. Comparative ease in reproducing inaccessible cavities.
4. A time saver in multiple preparations.
5. Adaptability to mouth reconstruction.
6. Comparative ease in establishing proper tooth form and margins.
7. Its accuracy makes for time saving in finishing.

There are certain fundamental factors which must be adhered to in the successful use of hydrocolloid. Clean dry cavities are imperative. It will be found helpful to clean each cavity with fine pumice, using a rubber cup or end brush before the impression is made. If this is done, the margins will appear much sharper on the

stone dies. Cavities must be dry, as hydrocolloid is so accurate, it will copy a film of blood or saliva.

All margins of the preparation must be exposed either by removing or by displacing interfering gum tissue. Hydrocolloid will not displace gum tissue. The problem of interfering gum tissue may be handled by surgery, cautery, or packing with cotton ropes, impregnated with some type of medicament (Fig. 5). At the present time, in my hands, the medicament of choice is 1 to 100 adrenalin-chloride. The cotton rope is saturated with the adrenalin, packed under the gum tissue, and allowed to stay in position about five minutes. It must be remembered that time and pressure are factors, as well as the medicament used. I have found that the 1 to 100 adrenalin-chloride seems to shrink the gum tissue, and control hemorrhage as well or better than other medicaments which are caustic.

Fig. 5.

To use hydrocolloid properly one must have the necessary equipment. It is desirable to have three waterbaths, thermostatically controlled. One water bath should be controlled at 208° to 210° F. for liquifying the material. Another bath should be held at 145° to 155° F., and will serve as a storage bath to keep the material in a workable condition at all times. The third bath is maintained at 106° to 113° F. This serves as a tempering medium. You will note that these temperatures have a rough leeway which is permissible, and can be regulated to suit the fancy of the operator. For example, if the tempering bath is set at 106° F., it will only be necessary to allow the Hydrocolloid to temper a minimum of three minutes before taking the impression, and the material will be workable up to about eight minutes. However, if the tempering bath is set at 113° F., the minimum tempering time would

be five minutes, and workable up to fifteen minutes. These variations do not violate any of the fundamentals involved, and are simply a convenience for each operator (Fig. 6).

Several small syringes are required with which to inject and fill the preparation with warmer and more fluid hydrocolloid (Fig. 7). The trays may be purchased ready made, with or without water-cooling apparatus. Trays may also be fashioned from perforated brass and designed to suit the case (Fig. 8). All trays should permit a bulk of material. Each tray must be blocked at each end, if possible, with a wax stop, which will rest on the teeth on either side of the prepared tooth. In the

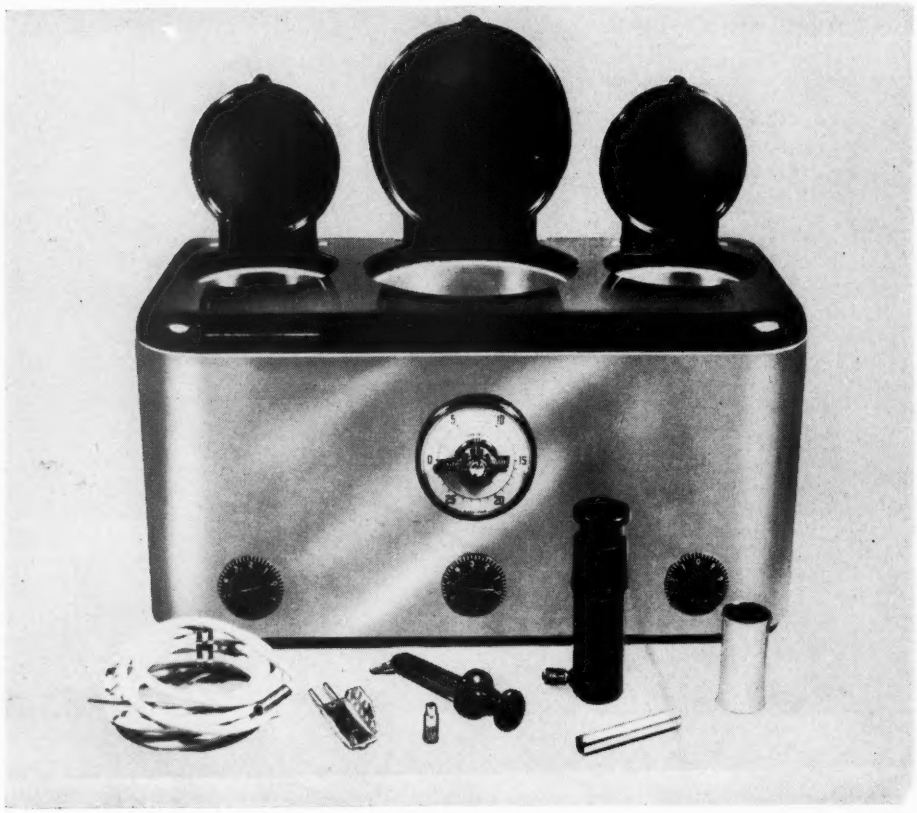


Fig. 6.

case of absence of teeth posterior to the preparation, the wax stop is made longer on the anterior portion of the tray, which will permit a bearing on several teeth anterior to the preparation (Fig. 9). These wax stops or rests serve as a definite place to seat the tray, and prevent it from touching any part of the prepared tooth. The finger pressure used in seating and holding the tray in position should always be in the center of the wax bearing area, to insure stability while chilling (Fig. 10).

In making the impression, the clean dry cavity is filled by injecting hydrocolloid with the small syringe, using care not to trap air. An excess of material is ejected

over the tooth to prevent premature chilling (Fig. 11). This is immediately covered with the tray of tempered hydrocolloid, (first wipe or blot the hydrocolloid surface with a cotton roll to remove any free water). The tray is quickly seated and held steadily in position while the material is chilled for a *minimum of four minutes.* In cases of deep extensions, or thin edges occurring in the impression, it will be found helpful to chill longer. It must be remembered in chilling hydrocolloid that

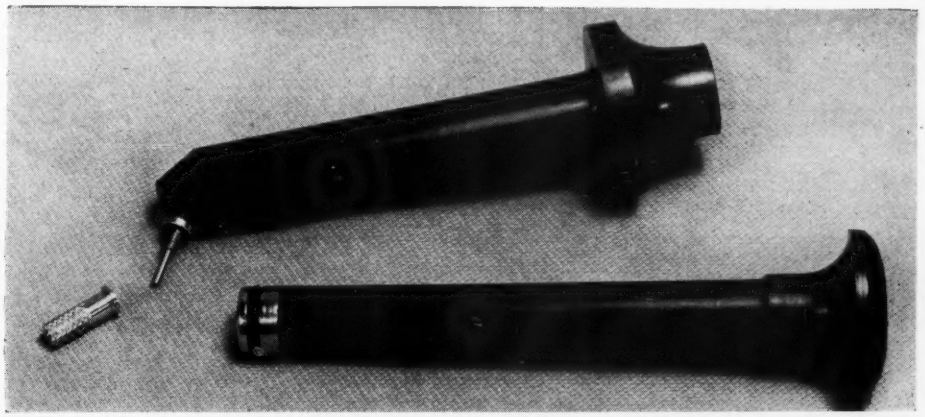


Fig. 7.

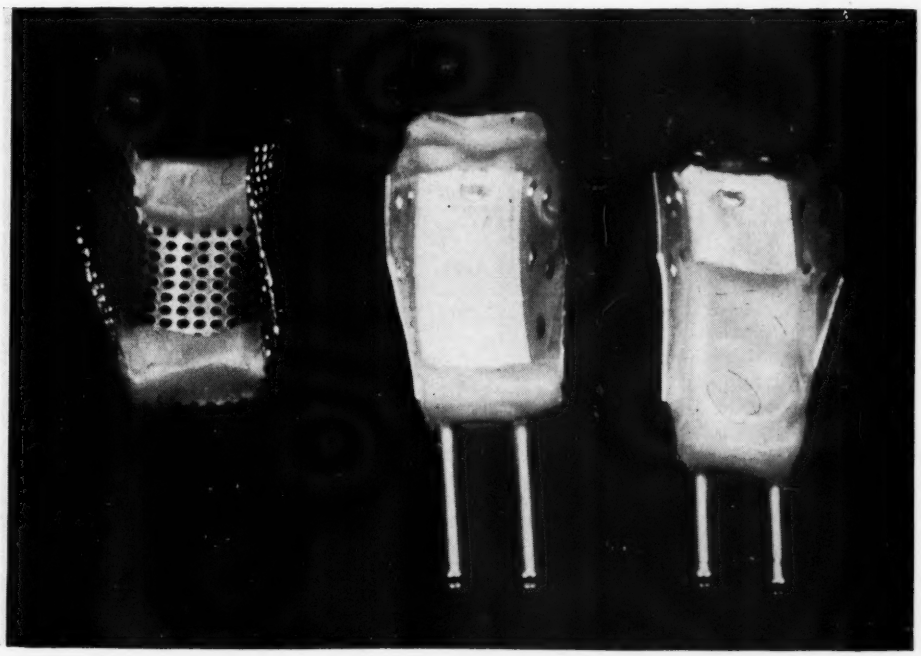


Fig. 8.

the material is a poor conductor and that time is as important a factor as the temperature of the water used. The use of tap or ice water seems to make no difference, if the chiling time is adequate. After thoroughly chilling, the tray is removed with a snap, using the fingers on the center of the under edge of the tray from the buccal and lingual.

The impression is removed and examined. If blood appears on the inside of the preparation, this impression should be discarded, as one not to be used for a master die. If acceptable, it is washed in running tap water, and then placed in a 2 per cent solution of potassium sulfate. The impression should be left in the solution for a minimum of five minutes, after which the stone die should be run as soon as possible. Make a second impression of the preparations if there are adjacent cavities. One cast will be sectioned into master dies, the other kept intact for contact determination and articulation.

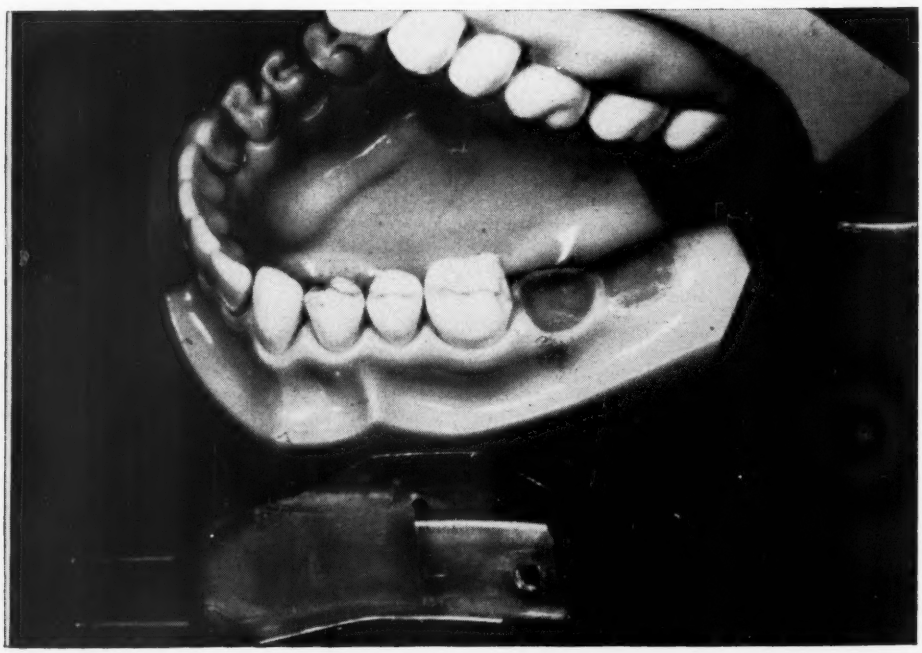


Fig. 9.

Some of the failures in the use of hydrocolloid may be attributed to the following:

1. Interfering gum tissue.
2. Inadequate chilling.
3. Distortion upon removal.
4. Dirty, wet, or bloody cavities.

Just as in all phases of dentistry, if the technique in the use of hydrocolloid is followed carefully, the results will be pleasing to the most fastidious operator.

Fig. 10.

Fig. 11.

In running the stone casts, the stone is vacuum mixed, never thinner than 25 parts of water to 100 parts of powder. Having blown out the excess K_2SO_4 solution from the impression, the stone is vibrated into the impression, using small amounts until the cavity portion is completely filled. A portion of the stone left is partially dried in a towel, and placed on top of the softer material in the impression. The poured impression should set thirty minutes before being separated. This results in a very hard stone die.

In preparing the stone dies, the power model trimmer, or a coarse stone, may be used. One should be cautious about particles from grinding adhering to the die, and also from over washing. Stone is slightly soluble in water, and the application of too much water will cause rounded margins. When the grinding is finished, the die should be dried with a blast of air.

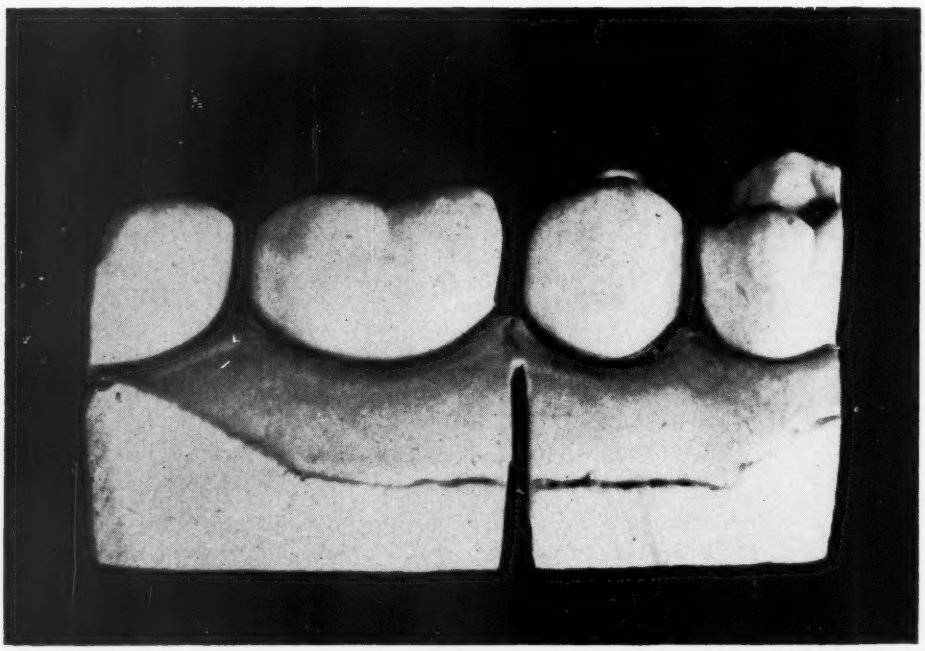


Fig. 12.

If it is necessary to separate several adjacent dies this may be done with a Joe-Dandy disc, cutting from the under side of the cast toward the gingivae, following predetermined pencil lines drawn toward the center of the interproximal space. If these cuts are made to within one-fourth inch of the interproximal gingival area, the cast can then be split easily with a laboratory knife (Fig. 12).

Further shaping of the individual die may be accomplished with a Bard-Parker surgical knife, using a No. 11 blade. It is very important to contour the root portion of each die, removing any bulk of stone which might prevent the proper use of a plastic instrument while contouring the margins of the wax pattern (Fig. 13). Today we have hydrocals which will give us very hard dies. If we handle these dies with care their accuracy will be evidenced in our final result.

OCCLUSION

There are many methods of establishing the occlusion, contact points, and general contour of wax patterns. In a single restoration, a preliminary wax pattern may be made in the mouth. This pattern may be "chewed-in" and will give the approximate occlusion and position of the contact points.

When we are dealing with multiple adjacent preparations, several impressions are made. It is necessary to have an accurate impression of each individual preparation, plus one other impression of all the preparations, from which a cast is made and mounted in a wax checkbite of the opposing arch. *It is well to keep in mind that this is the most opportune time to make all the impressions that may be needed.* Full articulated casts are often used, and with suitable registrations, mounted on any desired instrument.

Fig. 13.

WAXING

In waxing multiple adjacent preparations, the wax pattern is first fabricated on the master die. The melting of the wax on the stone die, having previously lubricated the die with Microfilm, is the method of choice. After the wax pattern is built to general contour on the master die it is removed and transferred to the articulated die. Here the occlusion, general contours, and contact points are established.

Dr. Morris Thompson advocates the dusting of talcum powder on the pattern and gently closing the articulator, to mark the contacts of occlusion. By carving the wax, and repeating this procedure, the desired occlusion is established without distortion, or the introduction of stresses. The final marginal refinement of the wax pattern is done on the master die. Small sections of the margins are traced with hot wax, using a small spatula, or wax pliers, and the added wax is melted in and over the margin to a depth of about one millimeter. While supporting the pattern, this added wax is held under slight pressure for a few seconds. This procedure is repeated until all the margins have been traced. Then, with a warm plastic instrument the margins are refined, using an ironing motion parallel with, and at an

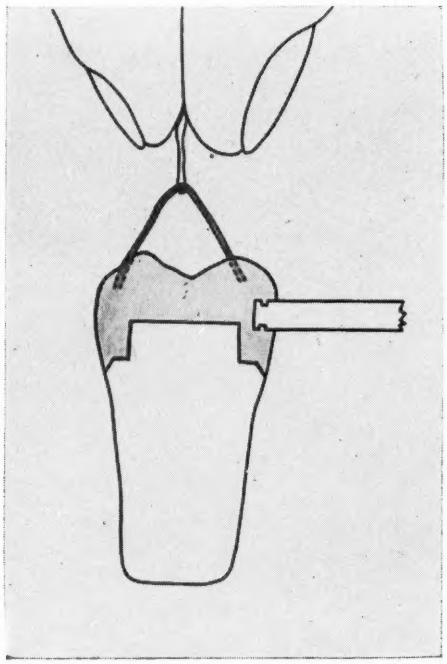


Fig. 14.

angle slightly toward the margin. Caution should be taken to hold the instrument at such an angle that will insure waxing to full marginal contour. By using a warm plastic instrument in this manner, the excess wax is removed, and marginal adaptation and refinement are secured.

There is no procedure in the making of a gold inlay more important than another, but some phases may offer more difficulties. Certainly, the final casting cannot be more nearly perfect than the wax pattern. The construction of this pattern should deserve most meticulous efforts. As we test the fit of our castings on the dies, or on the tooth in the mouth, we may be displeased with our results. Providing all other steps have been executed properly up to this point, we can usually

place the blame on making the wax pattern. The construction of a good wax pattern requires digital dexterity, but with the proper mental concept, and an understanding of handling wax, this step can be improved. Great care is exercised in removing the pattern from the die, for here there is a fine chance for distortion. Many patterns can be removed simply with a sprue. For the more complex types a "V" shaped staple made with 22 carat, 29 gauge gold wire is used, threading a piece of fine sewing thread through the "V" of the staple and carefully removing the pattern. The staple is left in place until after the casting is made (Fig. 14).

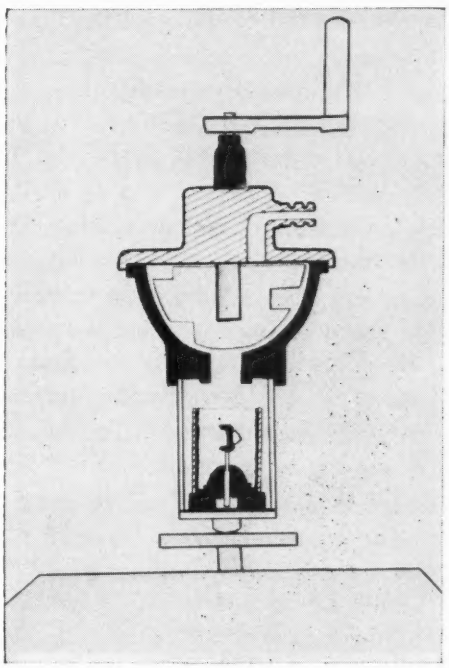


Fig. 15.

A small amount of low fusing carding wax is added to the pattern to make plus contact points, and the pattern is sprued and mounted on a rubber crater-former. If there is any wax on the margins of the die after the removal of the pattern, the die should be cleaned with chloroform, relubricated, and the pattern placed back on the die once again for final refinement.

A discussion of the direct method of making a wax pattern has been purposely omitted, although it is felt that this method skilfully done will give very satisfactory results.

INVESTING AND CASTING

The investing and casting technique is a mechanical procedure, and with ordinary care it is not difficult to execute.

If each step is followed carefully, the casting will be an accurate reproduction of the wax pattern. All patterns, whether they are large or small, and regardless of

shape, are treated in the same fashion. The shrinkage factor of the gold alloy is compensated for by a combination of hygroscopic and thermal expansion. The ring should be 1 5/16 inches in diameter, and 1⅜ inches long. It seems to be advantageous to use this size ring so that there will be adequate investment to take advantage of the hygroscopic and thermal expansion.

There are a number of inlay investments which can be used, but at this time the investment of choice in my hands is Cristobolite. The powder-water ratio for this investment is twenty cubic centimeters of water to fifty grams of powder. This proportion may be measured by weighing fifty grams of powder on a Ransom and Randolph scale, and twenty cubic centimeters of water with a pipette.

The water and powder are vacuum mixed, using a Hollenback mixing bowl. The bowl is designed with a hole in its base, so that the ring, previously lined with wet asbestos, may be sealed in this position. The use of a rubber crater-former permits the sealing of the ring at its engaging end, so that the entire assembly is sealed to maintain vacuum.

To further insure maintenance of vacuum during the investing process, a plastic cup, designed by Dr. Shooshan, fits over the entire assembly (Fig. 15).

The necessary vacuum may be produced by a water vacuum pump, or by a motor driven pump. The amount of vacuum necessary has not been established definitely, but probably 27 inches of mercury is sufficient. It is very important, however, to have a tight line with no leaks, so that the vacuum is constant.

If Microfilm has been used as a lubricant for the stone die, it will not be necessary to wash the pattern or use any of the wetting agents.

The powder and water are placed in the mixing bowl, and with the ring and rubber crater-former in position, vacuum is applied. It is well to have a dial or mercury gauge in order to observe the amount of vacuum produced, as well as its lack of interruption. The mixing bowl is held in a horizontal position, while the mixing is accomplished, to prevent the mix from running into the ring prematurely. The investment is mixed for one minute by hand, or if a motor is used, twelve seconds will suffice. Immediately following the mixing, the complete assembly, or mixer and ring, are held on a vibrator in an upright position, and the ring filled. This complete operation is accomplished in vacuum. After filling the ring, the vacuum should be released slowly and the filled ring is then removed from the assembly.

After the investment has set in the ring for thirty minutes or more, the crater-former and sprue may be removed, and the ring placed in a thermostatically controlled oven. The ring is placed in the oven at 600° F. for one-half hour. The oven is then turned up to 1,100° F. and held there for one hour. Following this, the casting is made.

When the casting has been made, I have found it advisable to allow the ring to cool for five minutes before placing under water. It has also been found advisable to boil the casting in dilute hydrochloric acid rather than heating and plunging.

There are many accurate methods of investing, burning out, and casting, but the foregoing method has proved successful in my hands.

The causes of pits and flaws in our castings seem to be due primarily to loose investment entering the mold with the molten gold. It is well always to examine the investment in our ring and remove these loose fragments before burning out.

The use of a reservoir seems to be unnecessary if we limit the length of our sprue to about one-fourth inch. Whether we use centrifugal or pressure casting seems to make no difference on the finished product, but we may take advantage of a larger sprue when making our casting by centrifugal force. When a large, short sprue is used, the button seems to serve the purpose of a reservoir.

FINISHING AND CEMENTATION

A well-organized finishing technique will improve the appearance and prolong the life of any casting, regardless of the efficiency with which it is made. The technique of finishing castings may be so routine that it need not be unduly time consuming. It is my belief that this finishing should be largely done on the tooth in the mouth.

There are certain fundamental principles involved in the finishing and cementation of castings, which should not be overlooked.

1. We must make room for the cement. If this is not done the principles of hydraulics will not permit us to closely approximate the seating of our castings during cementation.
2. The major part of the finishing is done before cementation. If any extensive finishing is done subsequent to cementation, cement lines will invariably appear.
3. The casting must be held firmly in place at all times during finishing. If this principle is violated, saw-tooth or wire margins will be inevitable.
4. A finely powdered cement should be used.
5. The tooth preparation should be kept dry during cementation. This can usually be best accomplished by the use of the rubber dam.

The steps in the technique of finishing are chronologically listed as follows:

1. Toilet of the preparation is made by use of fine pumice with rubber cup or end brush.
2. The entire inner surface of the casting is etched with aqua-regia, or ground with suitable sized burs, to within one millimeter of the margins. A small amount of gold is removed from this entire area, and large amounts are removed where it is desired to obtain a heavier cement foundation.
3. The casting is tried on the prepared tooth and contact points adjusted, using a carborundum disc and burlew wheels.
4. Firmly seat the casting, using mallet force and adjust the occlusion.
5. Calk all accessible margins, using small fine mounted stones on the occlusal margins, revolving the stone from the gold toward the tooth.
6. Calk gingival margins and remove any excess by use of gold files.
7. Disc all accessible margins with fine or medium sand discs, revolving the disc from the gold toward the tooth, always holding the casting firmly in place.

8. Remove the casting from the tooth and remove any file scratches by the use of fine discs or a burlew wheel, being cautious not to touch any of the margins.
9. Place the rubber dam (whenever possible), sterilize the cavity and apply a coat of Copalite varnish.
10. Mix cement on chilled slab. Cement the casting to place using mallet force followed by sustained pressure. This sustained pressure may be maintained by use of soft wood, or the Medarts inlay setter.
11. While cement is still soft, disc or burnish any margins which have a tendency to flare away from the tooth.
12. Remove the thoroughly hardened cement and strip the gingival margins, using a fine cuttle strip.
13. Disc all accessible margins, using fine cuttle discs, from the gold toward the tooth. *A Burlew wheel is never advocated for this purpose.*
14. Apply the final polish using a rubber cup and end brush with fine pumice followed by tin oxide or lap emery. Caution should be observed during the entire finishing process to avoid overheating the tooth.

As we look at our finished product in the mouth, we may be well pleased with our result.

SUMMARY

In summary may I re-emphasize that if we wish to improve our operative dentistry and become better balanced dentists, we must observe the following cardinal principles:

1. Thorough diagnosis, including full-mouth apical and interproximal x-rays, properly mounted accurate study casts, and clinical examination correlating all diagnostic findings.
2. Responsibility for the restoration of the health of the investing tissues of the mouth.
3. Proper treatment planning, including a visualization of each operation before its execution.
4. Instruction in daily oral hygiene and periodic patient recall in order to insure the maintenance of oral health.

Improvement in our operative dentistry will be insured, if we as operators study our results with the critical eye of self-analysis.

I wish we could all follow the wisdom of that famous artist, Michelangelo—you will all remember his words—

"Trifles make perfection—but perfection is no trifle."

416 North Bedford Drive
Beverly Hills, California

THE APPLICATION AND CONSTRUCTION OF THE PINLEDGE RETAINER

JOHN F. JOHNSTON, D.D.S.

Indiana University School of Dentistry, Indianapolis, Ind.

IN THE FIELD of anterior fixed partial dentures, stability and esthetics must receive equal consideration. The partial veneer crown, the gold crown with a veneer, the MacBoyle and the pinledge retainers have been used for many years. Stability has resulted with the partial and full veneer crowns and with the MacBoyle retainer, even though they may not have been constructed with finesse.

Esthetically, the MacBoyle retainer leaves much to be desired. To achieve a satisfactory result with the partial veneer crown, modifications must be made in the standard preparation.[1] The veneered gold crown poses the difficulties of over-preparation, contour, masking, and shading. In the hands of a few these problems are solved.

A correctly-designed and well-made pinledge requires the least cutting of the tooth and displays the least amount of metal. If used within its limitations, it is an excellent retainer. That it does have definite limitations has been demonstrated to the writer and his associates. Through a trial and error method, where at times it was used solely for experimental purposes, some definite conclusions concerning the indications and contraindications of the pinledge have been reached.

In those instances of failure, some small but highly important point was overlooked when calculating the stresses which would bear on the abutment teeth, in determining the mobility and leverage arcs of those teeth, and in measuring the lever arm necessary in the replacement. Analysis of the study casts had not been made with sufficient care. What had appeared to be a situation quite similar to one previously successful, proved—by failure—that it was influenced by a factor, or several factors, not present before. In almost every failure, a further study of the case showed a torsional stress produced by an unobserved, miscalculated, or disregarded thrust from the opposing jaw.

INDICATIONS FOR THE PINLEDGE ATTACHMENT

The pinledge should be used in the shorter bridges. It cannot be used where a twisting force will be placed on it, nor can there be the slightest stress on the abutment teeth when seating the bridge. It must go to place with a minimum of pressure; otherwise, the bridge must be broken and reassembled. The lever arm of the bridge must be short or be broken by intermediate abutments. The occlusion

Read before the Indiana State Dental Society, May 13, 1952.
Received for publication April 9, 1953.

should not be end to end unless the casting gives incisal protection of a type affording added stabilization. When the pinledge is used, all joints must be rigid.

The pinledge attachment can be used in the upper arch (1) on the central and lateral incisors when replacing a central incisor (Fig. 1, *a*); (2) on the cuspid and central incisor when the lateral incisor is missing (Fig. 1, *b*); (3) frequently on the central incisor with a partial veneer on the cuspid when replacing a central

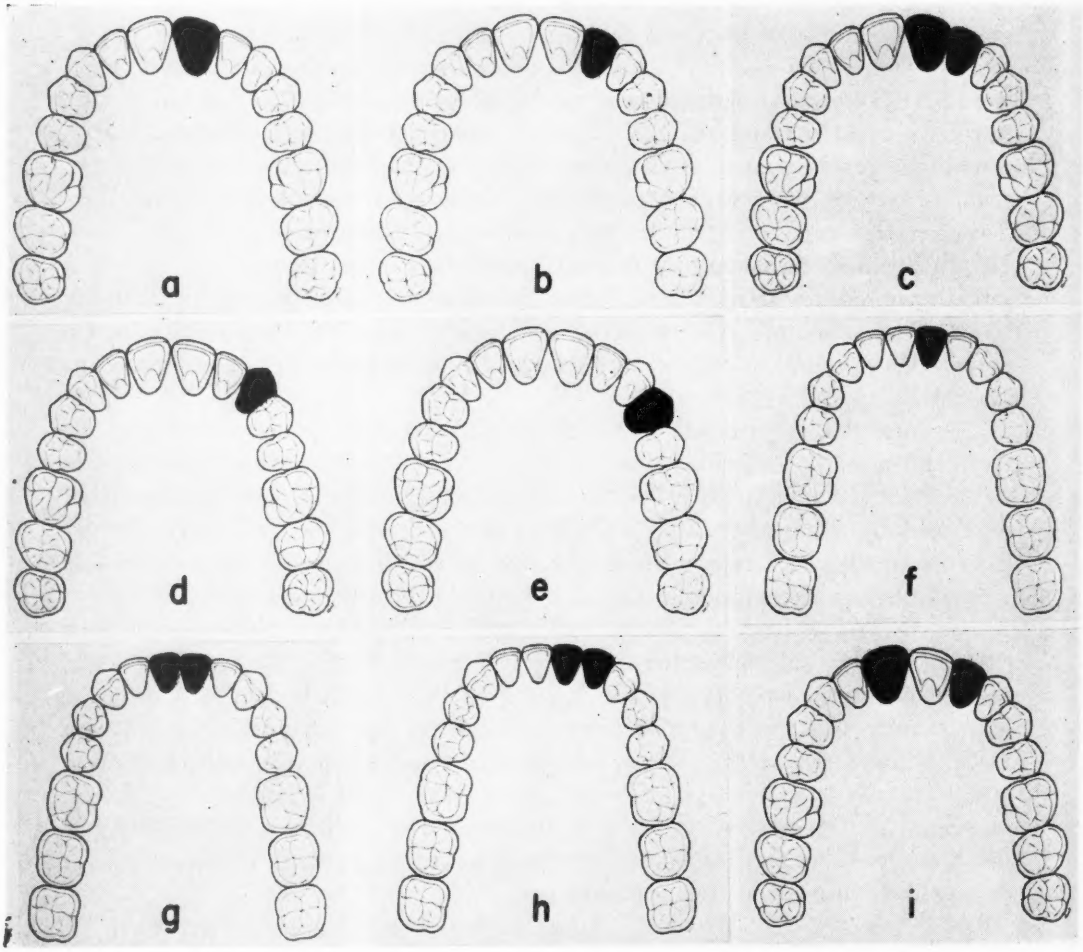


Fig. 1.—Indications for pinledge attachments.

and lateral incisor (Fig. 1, *c*); (4) in older patients on the lateral incisor with an inlay or partial veneer on the first biscuspid, when the cuspid is lost (Fig. 1, *d*); (5) if the occlusion and tooth form are favorable, on the cuspid with an inlay or partial veneer on the second biscuspid, when the first bicuspid space is to be filled. (If used here the pontic must have some occlusal modications.) (Fig. 1, *e*); (6) on the cuspid, central, and lateral incisor when replacing the lateral incisor on one side and the central incisor on the other (Fig. 1, *i*).

On upper teeth, with a few changes in the proximal portions of the preparation which tend to offset lingual displacement, it is frequently a better retainer than the partial veneer crown.[2] This applies particularly to cuspids with long mesio- and distoincisal arms, and with very short mesial and distal surfaces.

It is the retainer of choice in the lower arch (1) in the majority of cases when one or two central incisors must be replaced (Fig. 1, *f* and *g*); (2) when a lateral incisor is missing; (3) when central and lateral incisors must be inserted. By using a partial veneer on the cuspid and pinlays on the other central and lateral incisors, the bridge will have sufficient stability with a minimum of mutilation of the central and lateral abutments (Fig. 1, *h*).

Frequently lower incisors which must be used as abutment teeth have proximal caries. In such instances, the pinledge is contraindicated in favor of the MacBoyle retainer or veneered gold crown unless these cavities can be restored with gold foil before the retainer is constructed.

When filling the upper bicuspid spaces, I have used the pinledge on the cuspid, with a modified inlay in the first molar. Due to early failures, only 70 per cent success can be reported. That is not adequate. After a critical investigation of the successes and failures in this type of bridge, it is my opinion that the bad results were due, usually, to improperly evaluating an abnormal position of the lower second biscuspid. Being unable to go back and prove that point, my recommendation is that the pinledge not be used for the anterior retainer in such situations, although we probably shall continue to construct some bridges retained in this way.

The pinledge makes an ideal splinting attachment for loose lower anteriors, showing a minimum of metal and requiring the least amount of tooth cutting.

THE PREPARATION

The preparation of the pinledge must be planned from surveyed study casts and roentgenograms of the bite-wing type. In this way the pins can be placed to the mesial, distal, and lingual of the pulp and will in no way endanger it. There is absolutely no excuse for a pulp exposure when making this preparation—and I say so having done it at least four times in the twenty-seven years I have been using the pinledge. Two of these teeth were lost because the mishap was not discovered until after the bridge was seated and worn for a few days. The other two were capped and new postholes drilled after a suitable waiting period. Those teeth are *still* supporting bridges *and* with pinledge retainers.

The preparation is simple and very quickly done and should proceed in the following sequence of steps which has been standard for a number of years.[3, 4]

Step 1.—The reduction of the marginal ridge next to the space (Fig. 2). This is done with a Carborundum or diamond disk in the straight handpiece. It extends from midway on the cingulum area to the incisal edge and completely covers the contact surface, extending labially to the line angle. It is about 45 degrees from the plane of the lingual surface. It may or may not go through the enamel, but it usually does at some points. This cut should be made bearing in mind the intended line of insertion for the bridge.

Step 2.—The lingual surface is reduced evenly to a depth of ½ mm. from the original cut to—and frequently onto—the other marginal ridge (Fig. 2). This cut includes three-fourths of the incisal edge and one-half or two-thirds of the cingulum, depending on the length and form of the tooth. A small mounted stone having a round edge (either SSW No. 4 carborundum or Crescent No. 44-M diamond) is suitable. When the upper teeth are thin and the occlusion is close and overlapping, some compromise may be necessary. Grinding the incisal edges and upper labial surfaces of the lower teeth will help under such conditions.

On the uppers, when the occlusion is open, or on the lingual surfaces of lower teeth, less cutting should be done and the over-all thickness of the teeth increased; but, in any event, enough reduction must be made to produce a definite finishing line.

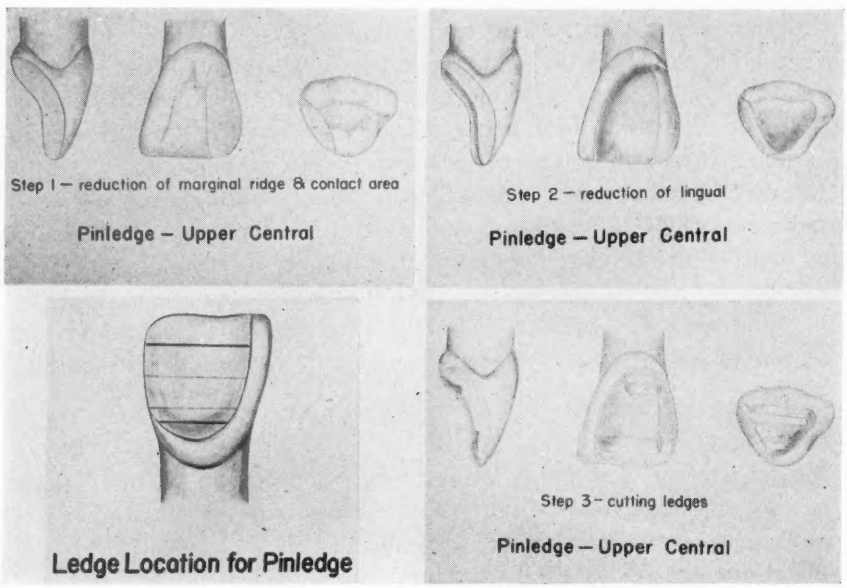

Step 1 – reduction of marginal ridge & contact area
Pinledge – Upper Central
Step 2 – reduction of lingual
Pinledge – Upper Central
Ledge Location for Pinledge
Step 3 – cutting ledges
Pinledge – Upper Central

Fig. 2.

Step 3.—Two ledges, running mesiodistally, are cut on the lingual surface, usually at right angles to the long axis of the tooth (Fig. 2). On the upper cuspid, the incisal ledge can follow the outline of the incisal edge of the tooth. These ledges support the retainer under biting stress, and make the pins more stable. The reduced portion of the lingual surface is divided into fourths, and the incisal ledge is made at the dividing line of the incisal section. *Now* the cervical fourth is divided in half, and on this new line the cervical ledge is cut.

For best results, these ledges should be as wide linguolabially as half the diameter of a No. 557 bur, and should extend mesiodistally completely across the *prepared* lingual surface. Either a small cylindrical stone or a No. 557 bur may be used in the straight handpiece. The width should be uniform from mesial to distal.

Step 4.—Before making the indentations, the roentgenograms and the study casts are again examined. It is necessary to *be certain* of the exact location of the pulp in order that the next cuts may be made to miss it. The depth of the proximal dentoenamel junction should be observed also. The incisal indentations are made *just inside* the marginal ridges or inside the dentoenamel junction and the one at the cervical *just off center* toward the space (Fig. 3). The greater the spread of these cuts, the greater the stability of the finished retainer. The No. 557 or No. 56 burs are best for this cut, the depth of which should be one-half the diameter of the bur used.

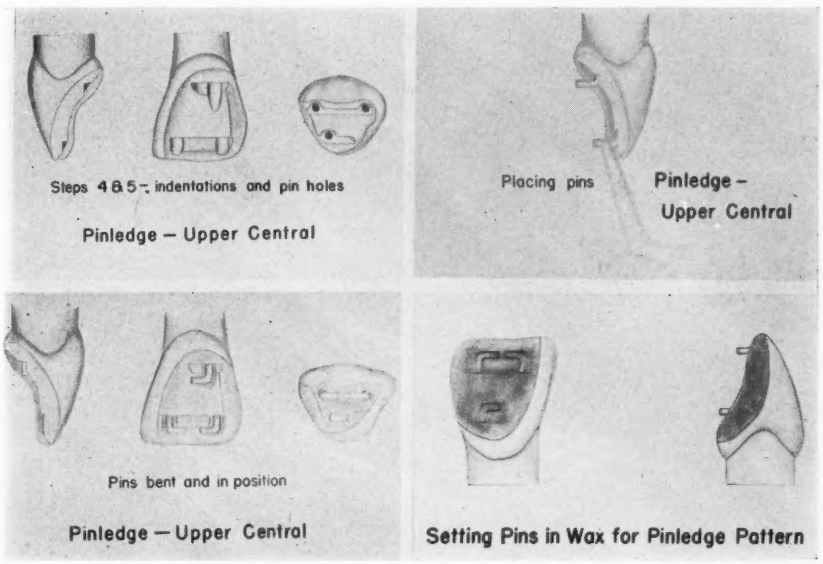

Steps 4 & 5 – indentations and pin holes
Pinledge – Upper Central
Placing pins
Pinledge – Upper Central
Pins bent and in position
Pinledge – Upper Central
Setting Pins in Wax for Pinledge Pattern

Fig. 3.

Step 5.—The pinholes are made with a No. ½ round bur in the straight handpiece and are best made with *no* anesthetic. The tooth sensation will serve as an additional guide to the location of the pulp horns. The bur is started in the center of the indentation and the holes are made parallel to the line of insertion, 2 mm. or 1½ mm. deep (Fig. 3). Very little pain is experienced by the patient, due to the limited time required for this step.

Step 6.—The incisal edge and incisal angle are bevelled and the cervical and lingual margins are chamfered (Fig. 3). This lingual finishing line must be very definite.

Some men advocate opening the postholes partway in with a No. 700 bur in order to allow easier seating of the casting. That may help some, but it certainly is not necessary. It usually results in postholes which are too large and in reduced retention. It is not advocated by us.

Twenty-four gauge platinum gold palladium wire is used for the pins, cut long enough to extend out of the hole ½ mm. and to have a right angle arm of not less than 1 mm. It is important that this arm be bent sharply at a right angle;

otherwise, the pins will not hold firmly in the pattern on withdrawal, and the casting will not seat. The Ney prepared pins can be used, but since these require a slightly larger hole, I prefer bent wire. The same is true of plastic pins.

The patient is asked to moisten the preparation with saliva before the pins are inserted. The pins can be placed readily in the holes and will be held there by the saliva and friction. Grasped with cotton pliers with the arm pointed into the mouth and away from the handle of the pliers, insertion will be easy (Fig. 3).

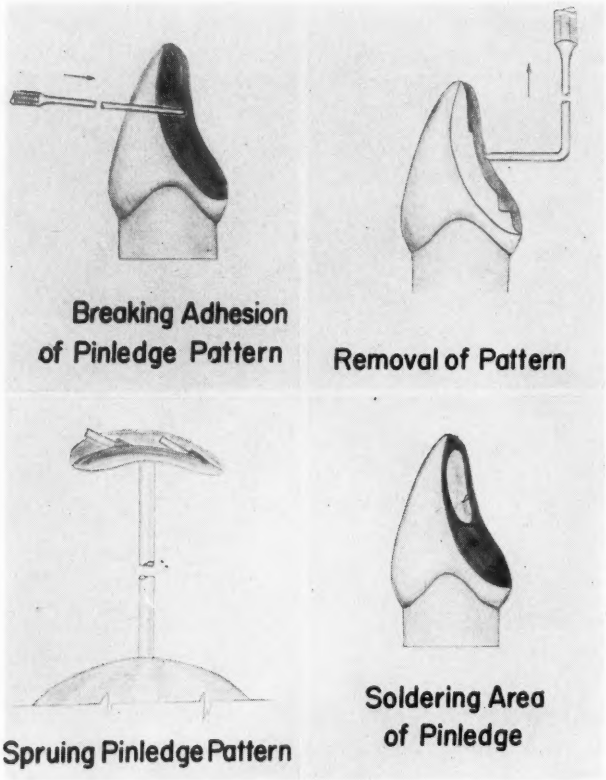


Fig. 4.

With the pin arms flat against the tooth surface, a soft piece of inlay wax is applied and pressed firmly to place against both the lingual and proximal surfaces. It is held on the lingual surfaces while the incisal and proximal surfaces are partially carved. The lingual wax is then reduced almost to tooth form. With a heated canal plugger, the wax is pooled over each pin, and the arm of the pin is turned so it is at right angles to the lingual surface. Again the wax is pooled, and the pin arms are pushed back against the tooth to their former positions. The carving is finished and the wax polished, leaving no excess for finishing except a very little on the incisal edge (Fig. 3).

Before the carving is completed, the pattern is loosened to make sure it will withdraw. Then it is reseated and the carving is finished (Fig. 4). If it does

not withdraw easily with a No. 5 explorer point engaging the lingual surface, the point is removed and, with the instrument inserted on the proximal, a little pressure is applied toward the lingual. (see Fig. 4.) The pressure must be stopped on the slightest movement, because that is sufficient to break the adhesion. Margins are readapted and removal of the pattern is again attempted, as previously described. The pattern is sprued on the lingual out of the mouth, at right angles to the ligual surface, using an 18-gauge sprue (which is the size of a No. 557 bur) (Fig. 4).

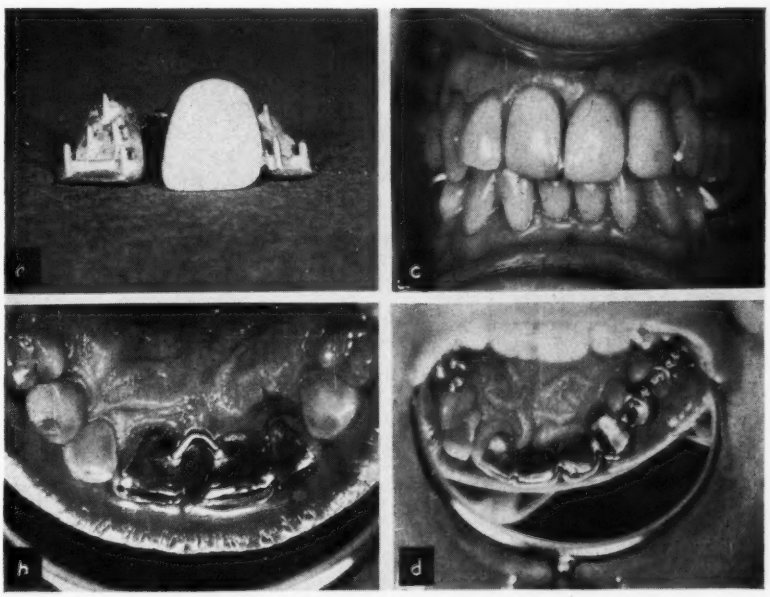


Fig. 5.—*a* and *b*, Bridge constructed in 1948. The number of posts was increased and, due to the added stress resulting from the dyastema, they were cast. This was possible because of the tooth form.

c and *d*, Bridge made in 1927, replacing the left central and lateral incisors.

CASTING

A very hard gold is required for these castings. This pattern would be classified under the heading of "Small One-Piece Castings" on the Cristobalite chart. Vacuum investing is strongly advocated for these patterns. Because of the proximity of the pins to the body of the pattern, and the many fine angles so vitally necessary to the stability of the retainer, even the most minute bubble will defeat all efforts to seat the casting. If the pinledge is to succeed, there can be *no* discrepancies.

In almost every instance, the pins for this attachment should be bent wire. There are, however, some places where the cast post can be used to much better advantage. For these, the holes are made with a No. 700 bur, and are sunk to a depth of 1 or 1¼ mm. When the pinledge is placed on lower incisors, the shorter, larger, closer-fitting cast pin gives a snug fit not obtainable on these teeth with the

bent wire. On upper lateral and central incisors, when the cingulum area is deeply indented, a post which is 1 mm. deep (and the size of a No. 701 bur) will serve better than the conventional wire pin (Figs. 5 and 6).

On the average tooth, the wire pins seat better than the cast posts and usually fit into smaller holes with less chance of a shadow showing through the labial enamel. Even where indicated, the tighter-fitting cast post sometimes traps air or cement, which makes the bridge more difficult to seat. The three wire pins are never perfectly parallel. It is this divergence which gives the retainer its stability after cementation.

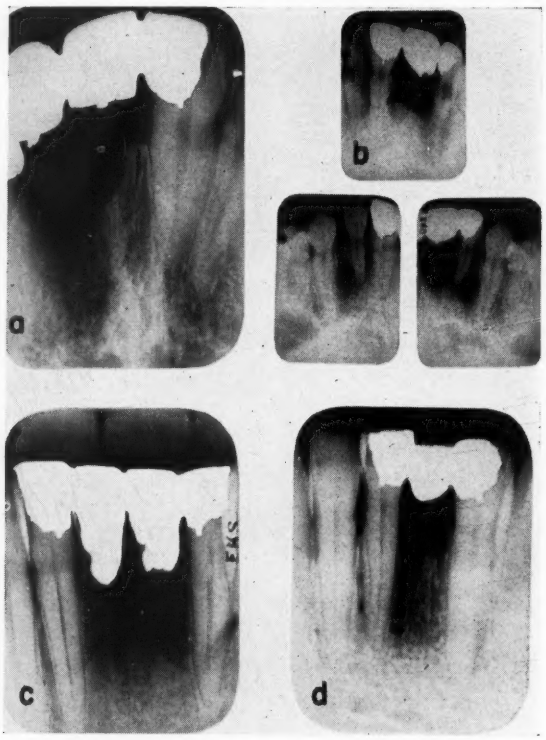


Fig. 6.—Roentgenograms of pinledge attachments.
a, The central incisor abutment of the bridge in Fig. 5, *c*.
b, Bridge replacing a central incisor, inserted in 1950. Orthodontic placement of these teeth precluded additional support.
c, Bridge replacing lower incisors, constructed in 1933.
d, Bridge replacing lower central incisor, constructed in 1946.

When the pinledge is tried on the tooth, it will be found occasionally that very slight mallet pressure is needed to seat the casting. The proximal margin is polished, using disks and a finishing bur. This surface cannot be reached after the bridge is cemented. The other margins are left untouched until after the fabrication of the bridge.

This retainer is difficult to seat accurately in a plaster impression. To aid in the assembly of the bridge units in the impression, it is good practice to lightly

notch the linguo-proximal surface near the soldering area after the occlusion has been corrected. This slight discrepancy will be filled during the soldering of the bridge.

SURVEY OF EFFECTIVENESS

Inasmuch as the pinledge retainer has long been an anathema in many teaching institutions, I should like to report our progress with it at Indiana University since its introduction here in 1949.

An incomplete survey shows that approximately 128 pinledges have been used. Available information may not be entirely accurate, but according to our records only two have come loose. There have been two exposures detected during the preparations. One of these was made by a staff member.

One tooth died because of an undetected pulpal contact. This was a "desperation" case. The tooth was unfit for a partial veneer, because the space was so short the full crown was not needed, and the proximal surface not involved in the pinledge preparation had a very deep Class III cavity restored with plastic. The chart showed that no sensation was experienced during the preparation of the postholes. However, since there is no record of a previous vitality test, the blame must rest with the Crown and Bridge Department.

When consideration is given to the fact that 128 preparations were made by senior students, with the maximum of supervision, but in most cases with only nominal help; that the patterns, also, were chiefly products of student endeavor; that the fitting, assembly and seating of these bridges were done by these same students, I feel that the results are rewarding and that the record wholly justifies the teaching of this retainer.

In my eagerness to stress the importance of thoroughness in diagnosis and accuracy in construction where the pinledge is concerned, it is possible that I have made it sound too difficult and too prone to failure. Such is not the case. While the technique is exacting, it is one easily mastered. The indications are not to be tampered with—nor are the contraindications. Under certain circumstances it simply cannot be used. Gamble with it and the failures may be consequential. Do not tempt fate and this retainer will serve you well.

Acknowledgment is made to John DuMond, Robert G. Botkin, F. K. Paul, A. N. Burks, Roland Dykema, H. J. Longcamp, Donald Cunningham, and Ralph Schimmele for the use of unpublished data.

REFERENCES

1. Grubb, H. D.: Fixed Bridgework, J. Pros. Den. **3**:121-126, 1953.
2. Tylman, Stanley D.: Crown and Bridge Prosthesis, ed. 2, St. Louis, 1947, The C. V. Mosby Company, pp. 371-376.
3. Doxtater, Lee Walter: Procedures in Modern Crown and Bridgework, Brooklyn, 1931, Dental Items of Interest Publishing Co., Inc., pp. 242-249.
4. Schweitzer, Jerome M.: Restorative Dentistry, St. Louis, 1947, The C. V. Mosby Company, pp. 35-36-37.

1121 W. Michigan St.
Indianapolis, Ind.

THE CEMENT APPLICATOR

A New Instrument For Applying Cement In Restorative Procedures

Louis Alexander Cohn, D.D.S.

School of Dental and Oral Surgery, Faculty of Medicine, Columbia University, New York, N.Y.

THE PROCESS of applying cement in deep, narrow, or inaccessible areas has been a problem for the following reasons: (1) the difficulty in depositing the cement where desired with ease yet with precision; (2) the frequent inability to control placement of the cement because of interference from the surrounding structures; (3) the difficulty encountered in controlling the amount of cement on the instrument; and (4) the poor visibility of the cement placement and of the area to which it is being applied.

In my experience the "000" sable hair brush bent to suit the specific situation has proved satisfactory for applying cement in the cavity of a tooth, particularly if the pulp has been exposed and capped. Tactile sense and finger-dexterity are developed to the highest degree thereby. However, the brush is only of value in depositing a small amount of cement when a single application suffices. Otherwise, the use of the brush entails disadvantages, particularly when repeated applications are needed to fill large, deep cavities. Furthermore, the cement cannot be manipulated properly with the brush in the cementation procedures for seating inlays, crowns, and bridges.

Most instruments used for cementation are called plastic instruments. They were designed to apply and mold temporary restorative materials and plastic fillings of various types. In general, however, most of the available instruments that are used have not been found satisfactory, because they cannot effectively cope with the problem of applying cement in restricted or inapproachable areas. Most of the instruments in common use are poorly balanced, and generally of incorrect design with the blade too short, too wide, or too thick. In view of the need for an instrument to meet the special requirements of delivering cement with ease and precision to deep, narrow, and inaccessible areas, a new instrument, called the "Cement Applicator," has been developed and found effective.

This instrument is made of the usual octagon stainless steel stock. The over-all length is seven and one-half inches. At one end, the shank of the instrument is formed in the shape of a hatchet; at the other end, the shank is formed in the shape of a hoe—so the effective end of the instrument is properly balanced with the handle. The length of each blade is 17 mm., the width 1½ mm., and the thickness ½ mm.

Received for publication March 18, 1953.

Each blade is tapered 1 mm. from the end of the blade, to form a blunted point. The hatchet end is a flat plane, while the hoe end has a slight curve, the radius of which is 15 degrees from the axis of the instrument (Fig. 1).

The shape of the "Cement Applicator" enables the dentist to pick up small amounts of cement at the instrument's tip. By virtue of the slightly curved end on the hoe side, the cement may be placed at will, and used with delicacy, either to cover a pulp-capped area or in any other cementing procedure. In fact, this instrument may also be used to apply selected material in capping exposed dental pulps, where pressure must be avoided.

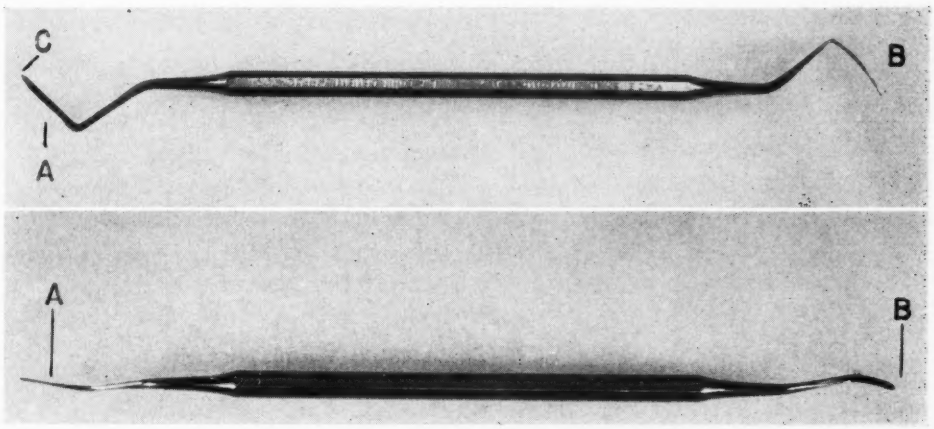


Fig. 1.—*Above,* Side view of the "Cement Applicator." *A,* hatchet end; *B,* hoe end; *C,* blunted tip. Note that the effective ends of the "Cement Applicator" are in line with the handle. This is obtained by a fully formed bin-angle design. Note also the gentle curve of the hoe end of the instrument.

Below, Top view of the "Cement Applicator." Note the narrowness of the hatchet and hoe blades.

The design of the instrument, and notably its balanced construction, permit all the finesse of the dentist's tactile sense to be fully realized. The length of the blade, on both the hoe and the hatchet ends of the "Cement Applicator," eliminates the hazard of covering the entire blade of the instrument with cement as is encountered with short bladed instruments. It also permits entry into deep areas without touching the surrounding structures with parts of the instrument not covered with cement, thereby providing freedom to operate. The use of the "Cement Applicator" for cementation enables the dentist to have good visibility of the field of application. The narrowness of the blade allows the slight leeway required to wipe or manipulate the cement against the surface to which it is being applied without having the instrument interfere with the proper placement of the cement.

The new "Cement Applicator" should facilitate the approach into deep interproximal areas lying subgingivally, where the buccal and lingual access is difficult. This advantage is especially evident in teeth where a cement base is required to fill a deep, carious excavation, or when cementing an inlay, in order to assure careful

placement of the gingival dam of cement without giving rise to bleeding of the gingival tissues. This precaution is particularly important when cementing an artifical crown to a tooth where the technique calls for lightly wiping cement against the gingival areas.[1]

A noteworthy advantage of the new instrument is the facility with which deep, narrow, artificial crowns of gold or porcelain can be filled with cement *without trapping air.* The narrowed apex of the instrument, together with its curve and length offers many advantages. It makes it possible to introduce cement from the lowest portion of the crown, to wipe the cement against the walls, gradually filling the internal areas as desired *without having the instrument touch the marginal areas* or impairing the visibility of the operation. When the cement is properly applied, no air is trapped when the instrument is withdrawn.

Moreover, these aids gained from the use of the "Cement Applicator" greatly facilitate the management of the cementation procedure so important in properly seating large units of fixed dental prosthesis.

REFERENCES

1. Cohn, Louis Alexander: The Acrylic Faced Cast Gold Crown, J. Pros. Den. **1**:112-134, 1951.

654 Madison Ave.
New York, N. Y.

PROGRESS REPORT ON FULL IMPLANT DENTURES

ISAIH LEW, B.A., D.D.S.

New York, N. Y.

WORKING on prosthetic structures in the oral cavity leads the clinician to the realization that all patients have to be treated as unique entities with individual problems, especially in the occlusion, anatomic configuration, and systemic reaction; that no set rationale is universally applicable; and that, aside from basic surgical principles, each candidate for implant dentures must be carefully studied, and individual plans must be made for prosthesis. It is for this reason that implant development has been accompanied by a constantly growing change in technique and rationale. These changes have been made for the purpose of meeting the exigencies that the particular patient presented. This is illustrated in the reports of Goldberg and Gershkoff,[1] Lew,[2] Berman,[3] and Ogus.[4]

Changes in the design of a lower implant were effected: (1) to avoid placing screws in the mandibular canal with the resulting parasthesia, a method of implantation has been developed which uses natural anatomic undercuts in the mandible, and temporary splinting for superstructures; (2) to avoid impingement on nerve tissue and blood vessels in the mental foramen, lower implants have been designed to circumscribe these areas by extending the design to the lingual in that region; (3) to eliminate postoperative impingement on the mucoperiosteum in case the implant should settle, the design of the abutments has been altered to avoid sharp platforms and protruding angles.

To overcome the edentulous period, to facilitate primary healing, to minimize postoperative swelling and the accompanying wound opening and loss of sutures, the immediate splint technique has been developed and used with gratifying results. This technique has made it possible to make implants effectively on ambulatory patients with little fear of postoperative sequelae.

The upper implant has been changed in design from that of the early arch-shape of Ogus,[4] to the palatal implant of Lew.[2] It has been changed to the present full palatal implant which we find necessary in order to effect greater rigidity. Screws or circumferential wiring can be eliminated in the lower implant, where rigidity is obtained by the utilization of undercuts, boxings, and immediate denture splints. But because of the very transient nature of the alveolar bone in the maxilla, maximum fixation must be obtained for upper implants by screws in the mid-torus area, and by the extension of the palatal portion of the implant as far anteriorly and posteriorly as possible.

Received for publication March 25, 1953.

Any tendency to have movements of abutments beyond the physiologic limits of the tissues surrounding it will cause tissue breakdown and mobility of the implant with a possibility of failure of the prosthesis.

The employment of various types of teeth in the superstructure has still left us with the search for the ideal tooth in implant construction. The common type methyl-methacrylate tooth which has been used since early implant efforts[1] has proved to be too soft. The increased efficiency of mastication of the implant apparatus causes such rapid wear that we have found it necessary to replace or reconstruct the occlusion on the superstructure within a year. This was necessary

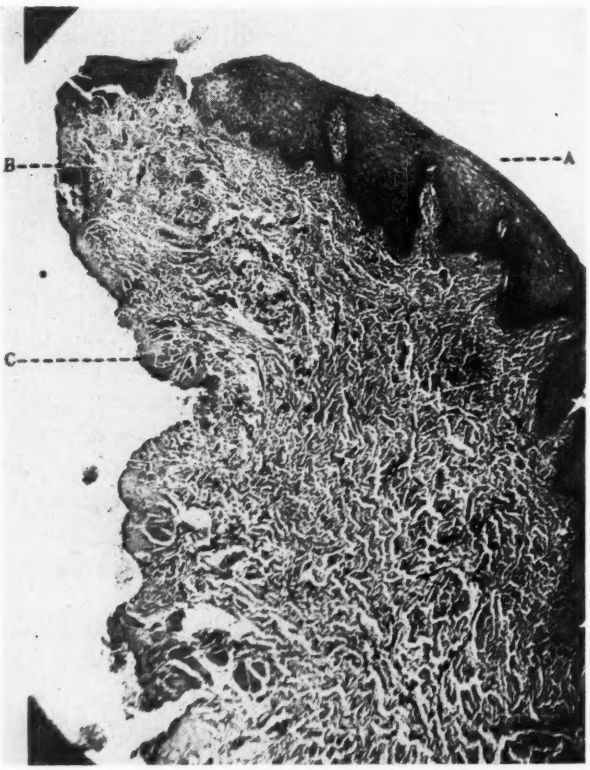


Fig. 1.—Low-power section through mucosa surrounding implant post. *A*, Normal mucosa. *B*, Specialized fibrous tissue contiguous to post of an implant abutment. *C*, Dense fibrous tissue surrounding the strut of an implant.

to restore the vertical dimension and the occlusal anatomy. Teeth with metal inserts on the occlusal surfaces[6] were tried, but with questionable improvement in masticatory function. This was probably due to the direct shock transmission to the underlying bone structure. Natural teeth show a Knoop test of 250 to 325 in hardness. Procelain teeth show a Knoop test of 400 to 425. This creates a harder impact on the implant than natural teeth would, and consequently burdens the underlying bone with excessive trauma in mastication. Plastic teeth generally show a Knoop test of only 20 to 21. Obviously they are too soft, as clinical

Fig. 2*A*.—High-power magnification of section *A* in Fig. 1. The section shows normal stratified squamous epithelium tapering off to a crevice not unlike that in a normal gingiva, until it reaches the implant post, where it forms a highly dense fibrous connective tissue of a specialized nature.

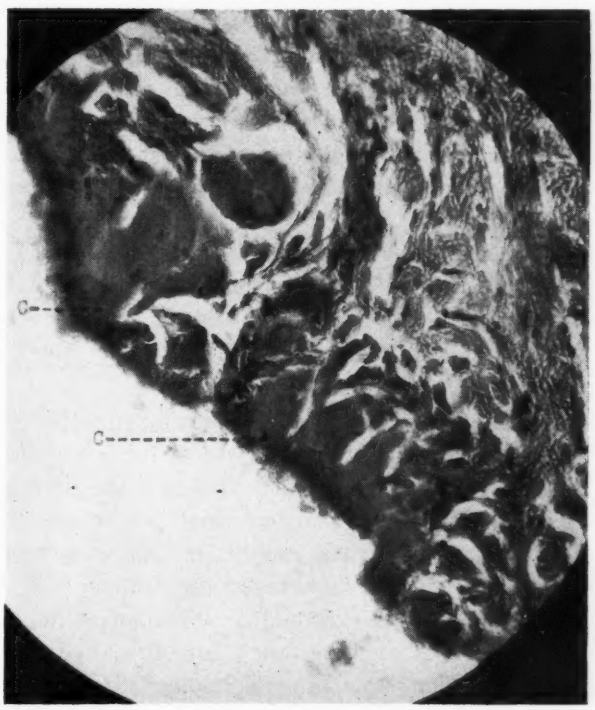


Fig. 2*B*.—Area *C* shows a large homogenous matrix resembling that of early hyaline cartilaginous tissue which takes a pink eosinophylic stain.

evidence has proved. Currently, we are using teeth with cross-linked polymers which have a greater Knoop test, and possibly a more lasting occlusal anatomy. The cross-linked polymer teeth being used resemble the design of the Hardy modified posterior teeth. Further time and effort will eventually provide us with the proper quality of tooth material for implant dentures.

Venable and Stuck[7] have indicated that only nonelectrolytic metals, such as Vitallium, Tantalum, and "18-8smo" in the chromium, molybdenum family were tolerated by tissue. To date, almost all of the implants inserted for full denture prosthesis, cleft palate repairs, and plastic replacement have been constructed of Vitallium. The use of plastics for implants has been suggested. No doubt, many materials and changes in the alloy structure can be contemplated. The metallurgical phase of implant construction provides a fertile field for research and improvement.

Histopathologic studies show that around a successful implant there is a thick compressed type of fibrous tissue which takes a light pink eosin stain in the matrix, with much flattened fibrocytes resembling that of early hyaline cartilage formation (Figs. 1 and 2). Contrary to the expressed views of many authorities who have never had the opportunity to observe implants academically, the so-called leakage around posts[5] is not the problem confronting the future of implants. It is rather the local factors of extensive tissue compression under super-structures, around the abutment platforms, and under freely movable implants (insecurely placed on the mandible or maxilla) which create inflammatory processes similar in nature to the parietal abcess or pericoronal inflammation. If they are treated promptly along accepted methods, they will resolve themselves uneventfully.

It is too early for us to determine the nature of responses to the implant by the patient suffering endocrine disturbances, senility, diabetes, and other debilitating conditions. Suffice it to say that the oral physiology does seem to create a specialized type of fibrous tissue to accommodate the implant; that the implant behaves differently in the mandible than it does in the maxilla; and that in both instances we find a response unlike that in any other part of the human anatomy. All of which verifies our concept of the oral tissue as being unique and highly differentiated from similar tissues elsewhere in the human body. Needless to say, we have barely scratched the surface of a field of research opened by the implant on problems that are unique to implant dentures.

Throughout the country over 400 full denture implants have been attempted. Some failures have occurred. They were certain to occur because of the limited knowledge of this subject by many of the clinicians attempting the operation. In analyzing the failures, which approximate a small percentage of all implants attempted, we find: (1) that the greatest number of failures were due to a lack of awareness of the rationale of implant dentures by the dentist; (2) that the fabrication of the implant structures was executed by laboratories not properly trained in implant construction; (3) that there was failure to utilize prosthetic, surgical, and histopathologic coordination in planning the implant; (4) that there was failure to realize that each mandible or maxilla must be treated as an individual problem considering (a) the height of the alveolar bone, (b) the position of the mandibular

canal, (c) position of the mental foramen, (d) presence of latent pathology (cysts, roots, etc.), (e) presence of tori, undercuts, fragile alveolar crests, (f) the density of the bone and bone anomalies; (5) the failure to select patients, e.g., failure to rule out patients' chronic debilitary diseases, emotional instability and excessive tendencies toward bruxism or other unfavorable occlusal habits; (6) the failure of the dentist or the patient or both to appreciate the limitations of implants, and the necessity for their complete cooperation.

Despite the causes for failures, over 400 implants have been placed in the mouth for periods of time ranging from six months to four and one-half years. The implant has given to these hopeless denture patients a long period of comfortable function, esthetics, and a sense of well being in a measure which more than justifies the heartaches and courage that has laid the groundwork for the successful implant.

Another facet which has afforded a great incentive toward implant research has come from the increasing longevity of patients, and the ever-increasing number of atrophied mandibles. Hopeless full denture patients pose a challenge to the dental profession in geriatrics. The full denture implant provides a promising channel through which we can contribute our measure of dental reconstruction which will enable an ever-growing number of senescent patients to assume an articulate, healthy, secure, and esthetic oral condition. Implant research has been progressing slowly and remarkably well, considering the fact that only practitioners who are highly desirous of improving their prosthetic patient's welfare have tirelessly labored for the realization of a more adequate prosthesis.

REFERENCES

1. Goldberg, N. I., and Gershkoff, Aaron: Implant Lower Denture, D. Digest **55**:490-494, 1949.
2. Lew, Isaih: Implant Denture—a Simplified Upper Technique Using Immediate Prosthesis, D. Digest **58**:10-15, 1952.
3. Berman, Nicholas: An Implant Technique for Full Lower Denture, D. Digest **57**:438-443, 1951.
4. Ogus, W. I.: Research Report on Implantation of Metals, D. Digest **57**:58-63, 1951.
5. Sullivan, E. J.: Discussion of Fundamentals of the Implant Denture by N. I. Goldberg and A. Gershkoff, J. Pros. Den. **2**:49-50, 1952.
6. Hardy, I. R.: Developments in the Occlusal Patterns of Artificial Teeth, J. Pros. Den. **1**:14-28, 1951.
7. Venable, C. S., and Stuck, W. C.: A General Consideration of Metals for Buried Appliances in Surgery, Surg., Gynec. & Obst. **76**:297, 1943.

36 W. 59th Street
New York 19, N. Y.

EXTENSIVE OBTURATORS

COMMANDER CHARLES W. MILLER, DENTAL CORPS, UNITED STATES NAVY

U. S. Naval Hospital, St. Albans, N. Y.

THIS IS a report of two cases involving the prosthetic repair of extensive palatal defects due to the surgical treatment of neoplasms.

CASE 1.—This patient, a 40-year-old Naval officer, was operated upon in 1945 for adenocarcinoma, cylindroma type, of the left antrum. A left partial maxillectomy was performed. The soft palate was not removed. The palatal defect measured about 4 cm. in length by 2 cm. at its greatest width. It was located in the area of the first and second left maxillary molars. The left maxillary teeth except the central incisor had been extracted prior to the patient's presentation for prosthesis. The remaining dental complement proved this to be a well cared for mouth. All the teeth of the right side of the maxilla were present and well restored.

The original prosthesis was a small acrylic obturator attached to a partial denture. The entire palate was covered, and the remaining maxillary teeth were clasped. The obturator both filled the defect and supported the missing left maxillary teeth. The prosthesis was stable, functioned exceedingly well, and required a minimum of accommodation by the patient. The patient returned to normal civilian life. He was considered 100 per cent rehabilitated.

Unfortunately, a recurrence was noted. The tumor was diagnosed as adenocarcinoma, salivary gland type. The second operation was done in December, 1951. A left radical maxillary resection including the left side of the soft palate was performed. The mucosa of the ethmoid and sphenoid bones on the left was removed. Posteriorly, the midline was crossed and the uvula was removed (Fig. 1).

The restorative prosthesis is in effect a complete maxillary denture, opened to allow for the remaining maxillary teeth (Fig. 2). The right buccal flange of the denture is cut well free of the teeth and their buccal gingivae. It fills the vault of the vestibule and affords an amazing amount of retention. On the lingual surface of remaining maxillary teeth, the denture is festooned so as to contact the teeth well above the gingival tissue. The left central incisor, the cuspid, the bicuspids, and molars were clasped with wrought wire, rest preparations having been made on their approximating marginal ridges and their attending fossae. The obturator closes the defect and supports the missing maxillary teeth. The obturator is a large hollow mound of acrylic (Fig. 3). It extends posteriorly until the superior constrictor muscle of the pharynx can make contact with it when in function. The height and the slope of the posterior surface of the obturator is of the greatest importance because when the patient swallows a very small portion of the bolus is forced superiorly. This is especially true of liquids. If this surface is correct, the extruded food will spend its momentum and be collected upon it instead of issuing from the patient's nose. The slope of the posterior surface is formed by the continued action of the superior constrictor on the impression material. The

---

The opinions and assertions contained in this article are the private opinions or assertions of the author and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large. Article 113, U. S. Naval Regulations.

Received for publication Nov. 19, 1952.

height is limited only by the weight and the efficiency of the prosthesis. In this case, in which the lateral boundary of the defect is the cheek, the height of the obturator afforded tissue contact as high as the malar bone. This greatly added to the stability of the case. Unfortunately, the eustachian tube was obstructed causing a forty decibel loss of hearing. Hearing was restored to normal with inflation of the tubes. Allowance for air interchange of the eustachian tube was made on

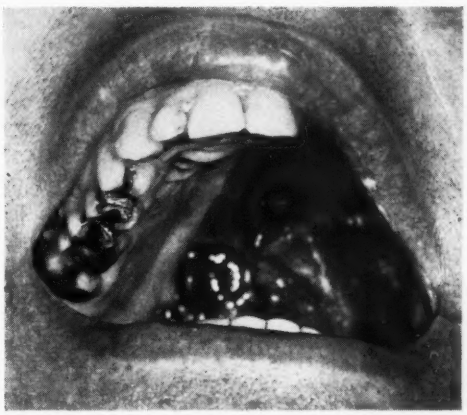


Fig. 1.—The palatal defect.

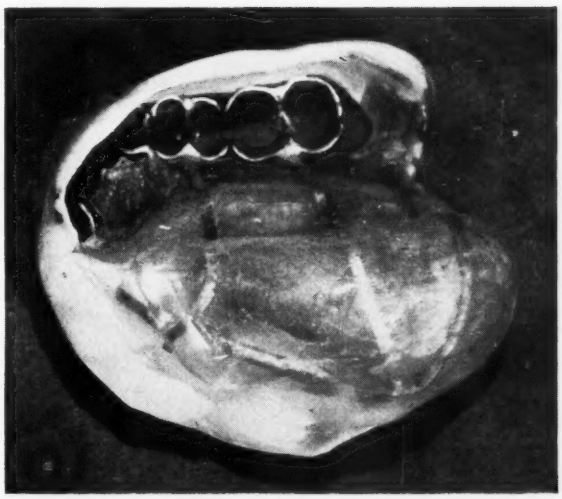


Fig. 2.—The prosthesis from a palatal view.

the obturator. Steel wires were imbedded in the acrylic so that the weight could be reduced to a minimum.

The patient was returned to his position in civilian society. He reports that no one has detected any change in his speech. He has accommodated for the inadequacies of the obturator and he gives the impression of a normal, happy individual. He is considered 100 per cent rehabilitated (Fig. 4).

Fig. 3.—The lateral posterior view.

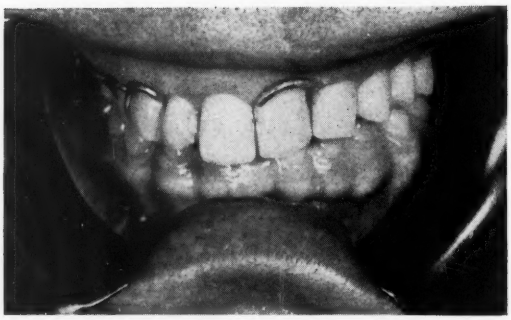


Fig. 4.—The restoration in the mouth.

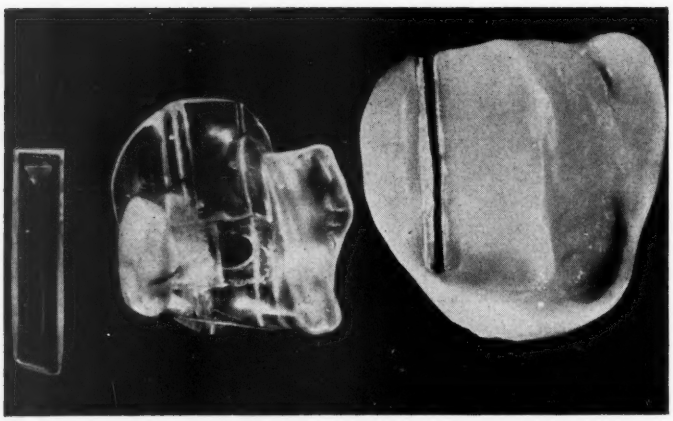


Fig. 5.—The three sections of the completed restoration. *Right,* the denture with a slide to attach it to the obturator. *Center,* the obturator with the thumb piece and ball retention in the lateral position. The wing on the opposite side fits above the hard palate remnant. *Left,* the slide that holds the thumb piece in the retentive position.

CASE 2.—This patient, a 51-year-old retired chief petty officer, was first operated on for carcinoma of the nasal septum in 1951. Dental restoration was also made in 1951. The original defect was an obliteration of the anterior alveolar ridge from cuspid to cuspid and the labial vestibule in that area. The mouth was edentulous but the alveolar ridges were ideal except for the defective area. The original prosthesis was a complete maxillary and mandibular dental prosthesis allowing for the defective area. The dentures were stable and functioned exceptionally well and required a minimum of adaptation by the patient.

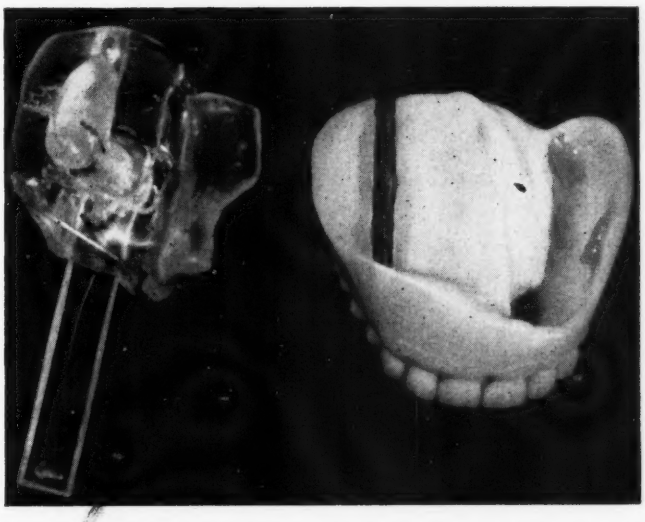


Fig. 6.—The slide lock partially inserted to lock the thumb piece in the lateral retentive position.

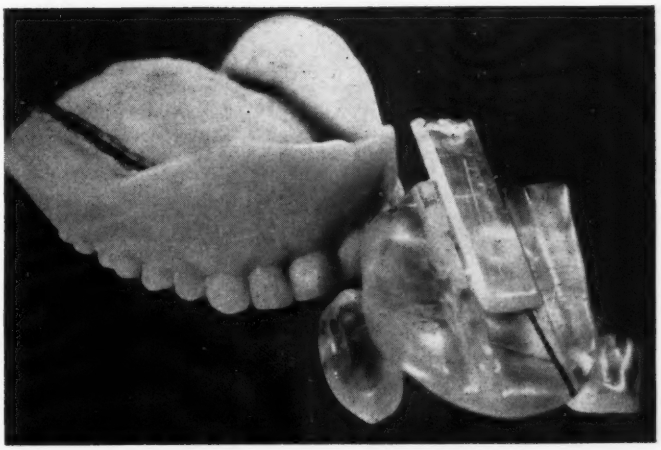


Fig. 7.—The obturator and slide lock as seen from the oral side.

Recurrence of the carcinoma on the right floor of the nose was noted, and the patient was operated upon during July, 1952. The present defect shows the loss of the entire right side of the hard palate, well beyond the midline. The right lateral maxillary wall, the lateral wall of the nose, and the turbinates were removed.

The obturator to close the defect in the hard palate was made of clear acrylic. On the left side it fits about 4 mm. onto the nasal surface of the remaining palatine process and about the same distance onto the oral surface, gripping the medial edge of the remaining palatine process with vicelike effect (Fig. 5). The rest of the periphery has a rounded border that covers the defect up to the edge of normal mucous membrane. Retention is obtained on the right side by pressure in the

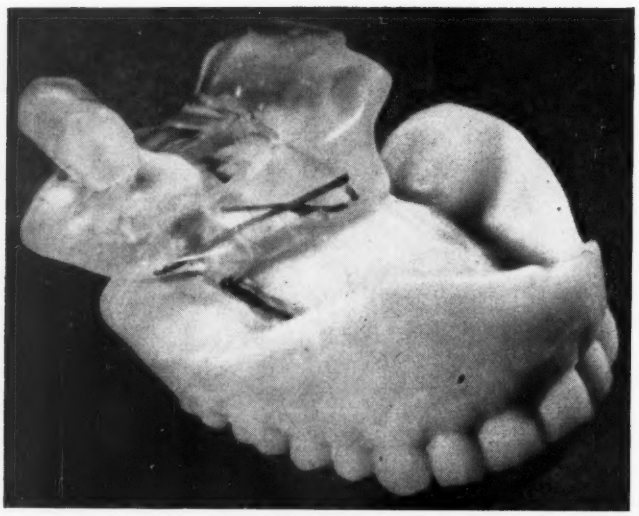


Fig. 8.—The denture partially attached to the assembled obturator.

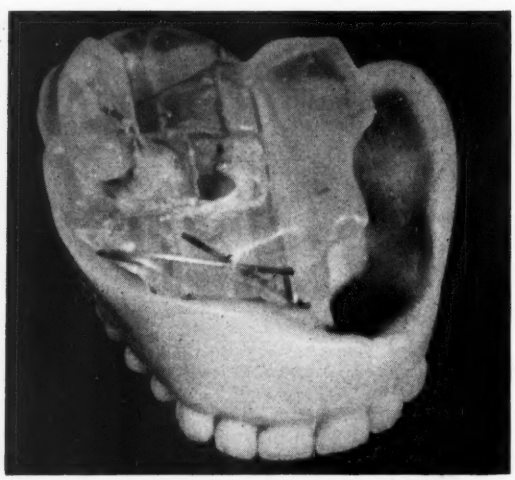


Fig. 9.—The complete prosthesis as it would be assembled in the mouth.

area of the malar bone. This is accomplished by an acrylic ball made to fit the dimensions of a depression in that bone (Fig. 6). Since the measurement of the defect increases superiorly, it is necessary to seat the obturator into an opening of smaller dimensions than the area affording retention. Therefore it is necessary that the acrylic ball, affording right lateral retention, be moved into its functional position after the obturator is seated. This is accomplished by having the ball on

a slide that fits a preparation on the nasal surface of the obturator. The preparation is opened to the palatal surface down the center of its entire length to allow for the attachment of a thumb piece so the acrylic ball can be moved laterally manually into its functional position (Fig. 7). This retentive apparatus is maintained in its lateral position by another slide which fits a preparation on the oral side of the obturator. This slide functions in an anteroposterior direction, and when in position it closes the opening in the obturator, thus keeping the thumb piece and the attached acrylic ball in functional lateral position (Fig. 3). The obturator is now in place. It is movable but it cannot be displaced unless it is released. In order that the maxillary denture can be retained it is necessary to add a track upon which the denture can slide into position. This track is placed approximately in the area of the right aveolar ridge and is set in an anteroposterior direction. It forms one continuous line with the thumb piece of the retentive ball when the obturator is secured in its functional position (Fig. 9).

TECHNIQUE

The dentures made previously to this operation were used after the palate of maxillary one was altered. This was accomplished by removing the palate of the denture, and building by hand a palate of soft wax. Then, with the teeth of both dentures fastened together by sticky wax in centric occlusion, and the mandibular denture rigidly retained on the mandibular alveolar ridge, a tactile centric relation at the former vertical dimension was registered. In this position the wax palate was chilled. This produced an inaccurate impression of the palate (both the artificial and the remains of the natural hard palate). By the careful use of a scalpel, enough wax was removed to allow for space for a zinc oxide and eugenol paste wash. Convenient stops were left in the wax to insure the proper seating of the impression which was registered with both dentures secured together. The maxillary denture was duplicated, and a gold casting was incorporated to receive the track of the obturator. The occlusion was equilibrated both on the articulator and intraorally.

The patient has been wearing the prosthesis with complete success. There is no nasal leakage and he is able to chew a fairly normal diet. He cannot manage foods such as steaks or chops but appears to be able to cope with all of the soft foods.

The patient has been able to remove and cleanse and maintain the prosthesis. His speech is completely understandable. His appearance is excellent. He gives the impression of being a normal, happy individual. He is considered 100 per cent rehabilitated.

U. S. Naval Hospital
St. Albans 12, N. Y.

AMERICAN BOARD OF PROSTHODONTICS

I. R. HARDY, D.M.D.

Tufts College Dental School, Boston, Mass.

THE American Board of Prosthodontics conducted its annual examinations for certification of specialists in Prosthodontics at the Indiana University School of Dentistry at Indianapolis, Ind., Feb. 2 to 6, 1953. Candidates were examined in the practical and theoretic phases of Prosthodontics. Twenty-two candidates were successful in meeting the requirements of the Board, and were certified. The addition of these new diplomates to the list of those previously certified increases the number of diplomates of the American Board of Prosthodontics to 146.

The members of the Board giving the examinations were *President,* Carl O. Boucher, *Vice President,* R. H. Kingery, *Secretary-Treasurer,* Irving R. Hardy, O. M. Dresen, Harold L. Harris, Vincent R. Trapozzano, Roland D. Fisher, Homer Simpson, and John I. Sloan.

Muller M. DeVan, Spruce Medical Building, Philadelphia, Pa., and S. Howard Payne, University of Buffalo Dental Department, Campus, Buffalo 14, N. Y., were elected to succeed Carl O. Boucher and Irving R. Hardy whose terms on the Board had expired.

The new officers of the Board are *President,* Richard H. Kingery, *Vice President,* O. M. Dresen, and *Secretary-Treasurer,* S. Howard Payne. Further information about the American Board of Prosthodontics may be obtained by writing to the Secretary at the University of Buffalo Dental Department, Campus, Buffalo 14, N. Y.

DIPLOMATES OF THE AMERICAN BOARD OF PROSTHODONTICS

Alabama

William L. McCracken	Dental School, University of Alabama, Birmingham

California

C. Walter Cole	31st & Macdonald Aves., Richmond
E. Leslie Eames	715 Pacific Mutual Bldg., Los Angeles 14
Roland D. Fisher	604 South Central Ave., Glendale 4
J. Raymond Gill	450 Sutter Street, San Francisco
Fred N. Harris	386 Walnut Street, East, Pasadena 4
David W. McLean	1135 W. Huntington Drive, Arcadia
Earl Pound	Suite 1003, 3780 Wilshire Blvd., Los Angeles
George A. Selleck	450 Sutter Street, San Francisco
Clawson N. Skinner	603 Bank of America Bldg., Whittier
Wilfrid H. Terrell	627-635 First Trust Bldg., Pasadena
Morris J. Thompson	409 North Camden Drive, Beverly Hills
Jack Werner	College of P. & S. School of Dentistry, 344 Fourteenth Street, San Francisco 3
Robert C. Zeisz	490 Post Street, San Francisco 2

Connecticut

Jack M. Buchman ..... 85 West Street, Danbury

Colorado

Bertram Downs ..... 629 No. Nevada Ave., Colorado Springs
Harold L. Harris ..... 1325 East 16th Street, Denver 5
V. Clyde Smedley ..... 1206 Republic Bldg., Denver

District of Columbia

George E. Emig ..... 3900 Reservoir Road N. W., Washington
William W. Hurst ..... 1825 H Street N. W., Veterans Administration Regional Office, Washington 25
Sidney S. Jaffe ..... 1314 Eighteenth Street N.W., Washington 6
Luzerne G. Jordan ..... 1801 Eye Street N. W., Washington 6
Edwin G. Kerans ..... Veterans Administration Hospital, 2650 Wisconsin Ave., N. W., Washington 25
Lindell L. Leathers ..... Suite 55, Parkwood Medical Bldg., 1746 K St., N. W., Washington 6

Florida

Samuel E. Misner ..... 1001 Huntington Bldg., Miami 32
Gustave J. Perdigon ..... First National Bank Bldg., Tampa 2
Andy W. Sears ..... 2705 Atlantic Blvd., Jacksonville
W. Ross Stromberg ..... 1826 N. Orange Ave., Orlando
Vincent R. Trapozzano ..... Box 518, New Port Richey
Harry W. Tustison ..... 230 S. Federal Highway, Dania

Illinois

Joe Whit Daily ..... 426 Illinois Bldg., Champaign
Carl W. Gieler ..... 4753 Broadway, Chicago 40
LeRoy E. Kurth ..... 25 E. Washington Street, Chicago 2
John B. LaDue ..... 25 E. Washington Street, Chicago 2
Arthur L. Roberts ..... Aurora National Bank Bldg., Aurora

Indiana

John W. Geller ..... 704 Bankers Trust Bldg., Indianapolis 4

Iowa

Carl T. Ostrem ..... 1107 Equitable Bldg., Des Moines
Earle S. Smith ..... 613 East Court Street, Iowa City

Kansas

Glenn E. Tilton ..... 1006 Union National Bldg., Wichita 2

Kentucky

Louis S. Block ..... 774-776 Starks Bldg., Louisville 2
Elam Harris ..... 607-608 Fincastle Bldg., Louisville

Maryland

James E. Pyott ..... 206 Medical Arts Bldg., Baltimore 1
F. Noel Smith ..... Medical Arts Bldg., Baltimore 1

Massachusetts

Irving R. Hardy ..... Tufts College Dental School, 136 Harrison Ave., Boston 11
John R. Wallace ..... 31 Church Street, Winchester

Michigan

Charles H. Jamieson ..... 563 David Whitney Blvd., Detroit 26
Horton D. Kimball ..... 873 Lakewood Blvd., Detroit 15
Richard H. Kingery ..... University of Michigan School of Dentistry, Ann Arbor

P. C. Lowery ..... Lowery Bldg., Gratiot & Burns, Detroit 13
A. Alfred Nelson ..... 245 West Ten Mile Road, Royal Oak
Chester K. Perry ..... 16350 East Warren Ave., Detroit 24
Albert J. Richards, Sr. ..... 735-739 David Whitney Bldg., Detroit 26

Minnesota

Ralph W. Boos ..... 808 Nicollet Ave., Minneapolis
Walter S. Warpeha ..... 1312 Second Street N. E., Minneapolis 13

Missouri

Emmett Beckley ..... 1018 Professional Bldg., Kansas City 6
Dayton D. Campbell ..... 411 Nichols Rd., Kansas City 2
Otho Duncan ..... 836 Argule Bldg., Kansas City
Philip M. Jones ..... School of Dentistry, University of Kansas City, 1108 East 10th Street, Kansas City
William P. Katz ..... 1012 Paul Brown Bldg., St. Louis
Chastain G. Porter ..... 255 Plaza Bank Bldg., 4711 Center Street, Kansas City 2

Montana

Wallace W. Cloyd ..... 114 No. Second Street, Livingstone

Nebraska

Bert L. Hooper ..... University of Nebraska School of Dentistry, Lincoln 4

New Jersey

L. Thomas Asche ..... 37 James Street, Newark
James V. Giordano ..... 425 Union Ave., Paterson 2
Leonard Gray ..... 31 Lincoln Park, Newark

New York

I. Kenneth Adisman ..... 100 Central Park South, New York 19
Louis Blatterfein ..... 1 Hanson Place, Brooklyn 17
Ira E. Klein ..... 2021 Grand Concourse, New York 53
Harold J. Levine ..... 123 West 57th Street, New York 19
Raymond J. Nagle ..... New York University, College of Dentistry, 209 E. 23rd Street, New York 10
S. Howard Payne ..... University of Buffalo Dental School, Campus, Buffalo 14
Max A. Pleasure ..... Columbia School of Dental & Oral Surgery, 630 West 168th Street, New York 32
Clyde H. Schuyler ..... 400 Madison Ave., New York 17
Thomas E. J. Shanahan ..... 862 Carroll Street, Brooklyn 15
Stanley G. Standard ..... 225 West 34th Street, New York

North Carolina

Lucian G. Coble ..... 330 Jefferson-Standard Bldg., Greensboro
Walter A. Hall, Jr. ..... University of North Carolina, School of Dentistry, Chapel Hill

Ohio

Theodore A. Bodine ..... 904-905 Akron Savings & Loan Bldg., Akron
Carl O. Boucher ..... Ohio State University College of Dentistry, Columbus
James D. Chessrown ..... 905 Mahoning Bank Bldg., Youngstown
Samuel S. Cohen ..... 2089 East 100th Street, Cleveland
Walter J. Pryor ..... 1020 Rose Bldg., Cleveland
John I. Sloan ..... 1032 Rose Bldg., Cleveland

Oklahoma

Gustav A. Roelke ..... 1112 Medical Arts Bldg., Tulsa

Oregon

Saul C. Robinson ..... 1203-1205 Selling Bldg., Portland 5
Merrill G. Swenson ..... University of Oregon School of Dentistry, 809 N. E. 6th Ave., Portland

Pennsylvania

Muller M. DeVan ..... University of Pennsylvania, Thos. W. Evans Museum & Dental Institute School of Dentistry, 40th & Spruce Streets, Philadelphia
Charles P. Egoville ..... 712 No. 63rd Street, Philadelphia 31
Russell W. Tench ..... 550 College Ave. W., York
Walter F. Wade ..... 258 West 10th Street, Erie

Tennessee

Elmer E. Francis ..... 708 Medical Arts Bldg., Memphis 3
Herman C. Levitch ..... Kennedy Veterans Administration Hospital, Memphis

Texas

Eugene L. Brown ..... 705½ W. Magnolia, Fort Worth
Frederick C. Elliott ..... 2345 Quenby, Houston 5
Edgar T. Gillean ..... 1219 Medical Arts Bldg., Dallas 1
Thomas H. Kennedy ..... 35 Highland Park Shopping Village, Dallas 5
John B. Larkin ..... 3217 Montros Blvd., Houston 6
Homer Simpson ..... 1324 Medical Arts Bldg., Dallas 1
Lewis P. Turner ..... 845-847 Milam Bldg., San Antonio 5

Utah

Victor H. Sears ..... 501 Tribune-Telegram Bldg., Salt Lake City 1

Virginia

Stuart J. Horner ..... Medical College of Virginia School of Dentistry, Richmond 19

Washington

Charles S. Ballard ..... 1129 Medical-Dental Bldg., Seattle 1
Bernard Jankelson ..... 652 Stimsen Bldg., Seattle 1
Claud J. Stansbery ..... 1217 Medical-Dental Bldg., Seattle 1

West Virginia

Edward J. DeKoning ..... 302 City Bank Bldg., Wheeling
Jed C. Wilcoxen ..... 20 Dunbar St., Charleston

Wisconsin

O. M. Dresen ..... Marquette University Dental School, 604 No. 16th Street, Milwaukee 3
Lawrence W. Gabert ..... (Res.) 6631 W. Center Street, Wauwatosa 13
Daniel H. Gehl ..... 2510 W. Capitol Drive, Milwaukee 6
Joseph E. Hoffman ..... 606 W. Wisconsin Ave., Milwaukee 3
Leslie E. Wilde ..... Veterans Administration Hospital, Wood

DIPLOMATES OF THE AMERICAN BOARD OF PROSTHODONTICS IN THE ARMED SERVICES

United States Army

William P. Barnes, Jr. ..... U. S. Army Hospital, Fort Bragg, N. C.
Roy L. Bodine, Jr. ..... 3124 Bransford Road, Augusta, Ga.
Lynn C. Dirksen ..... Army Medical Center, Central Dental Lab., Washington 12, D.C.
Pierre O. Evans ..... Army Hospital, U. S. Military Academy, West Point, N. Y.
James M. Fairchild ..... U. S. Army Dispensary, Rm. 2-D-201, The Pentagon, Washington 25, D.C.
George B. Foote ..... Box 6306, Fitzsimmons Army Hospital, Denver 8, Colo.
Charles D. Hemphill ..... 2250 North Point, San Francisco 23, Calif.
Frank C. Jerbi ..... (Res.) 465 Graham Road, Fort Sam Houston, Texas
Ellsworth K. Kelly ..... Dental Service, Madigan General Hospital, Tacoma, Wash.

Paul A. Miller ..... Hdqts. Tripler Army Hosp., Box 267, APO #438, c/o P. M., San Francisco, Calif.
Marion L. Mills ..... Office of the Post Dental Surgeon, Fort Dix, N. J.
James B. Neil ..... Tokyo Army Hospital, APO #1052, c/o P. M., San Francisco, Calif.
Edmund S. Olsen, Jr. ..... U. S. Army Hospital, Outpatient Dent. APO #503 8168th Army Unit, c/o P. M., San Francisco, Calif.
Arthur H. Schmidt ..... 3700 Medical Group, Lackland Air Force Base, San Antonio, Texas
Julius C. Sexson ..... Box 166, Brooke Army Hospital, Fort Sam Houston, Texas
Edwin H. Smith, Jr. ..... Walter Reed Hospital, Washington 12, D.C.
Robert L. Walsh ..... Box 249, Letterman Army Hospital, San Francisco, Calif.

United States Air Force

Leslie R. Allen ..... Box 923, Randolph Air Force Base, Randolph Field, Texas

United States Navy

Alfred W. Chandler ..... 5209 Andover Road, Chevy Chase, Md.
Judge C. Chapman ..... Naval Dental School, NNMC, Bethesda 14, Md.
William W. Dann ..... U. S. Naval Dental Clinic, Gun Factory, Washington 25, D. C.
Wm. McD. Fowler ..... 3330 Dumas Street, San Diego 6, Calif.
Arthur R. Frechette ..... U. S. Naval Training Station, San Diego, Calif.
Alvin H. Grunewald ..... Dental Service, U. S. Naval Hospital, Great Lakes, Ill.
Frank E. Jeffreys ..... 1738 S. Horne Street, Oceanside, Calif.
Jos. E. Josephson ..... USS Delta (AR-9), Fleet PO, San Francisco, Calif.
Stephen T. Kasper ..... Dental Clinic Navy 128, c/o Fleet PO, San Francisco, Calif.
Frank M. Kyes ..... U. S. Naval Amphibious Base, Little Creek, Norfolk, Va.
John V. Niiranen ..... 4609 W. Virginia Ave., Bethesda, Md.
Benjamin W. Osterling ..... U. S. Naval Hospital, Corona, Calif.
Mack L. Parker ..... Naval Dental School, NNMC, Bethesda 14, Md.
Jack H. Sault ..... Dental Dept., U. S. Naval Hospital, Philadelphia 45, Pa.
John B. Stoll ..... U. S. Naval Dental Clinic, Naval Gun Factory, Washington 25, D.C.
Harold R. Superko ..... Dental Detachment, U.S.M.C.R.D., Parris Island, S. C.

News and Notes

ANNOUNCEMENTS

The 1953 annual meeting of the American Denture Society will be held Friday and Saturday, Sept. 25 and 26, 1953, at the Hollenden Hotel in Cleveland. Members should make their hotel reservations at once on the blanks furnished by the American Denture Society.

The American Academy of Implant Dentures will meet in Cleveland, Ohio, in the Allerton Hotel on Sept. 27, 1953. For reservations, write to Dr. William E. Barb, 668 E. Maple Road, Indianapolis, Ind. For further information, write to Dr. M. W. Mueller, 1172 Lowry Medical Arts Bldg., St. Paul, Minn.

The Southeastern Academy of Prosthodontics was formed at an organizational meeting held in Atlanta, Ga., on March 22, 1953. The States of North Carolina, South Carolina, Georgia, Florida, Alabama, Tennessee, and Mississippi embrace the territory from which the membership is comprised.

Its purpose, as stated in the preamble of the constitution and by-laws, is "That it has been felt there is a definite need for such an Academy in the Southeast in the best interest of the public and the profession, and to promote and advance that branch of the art and science of dentistry pertaining to Prosthodontics."

The following are the newly elected officers:

Dr. Henry C. Parker, *President*
Charlotte, N. C.
Dr. G. J. Perdigon, *President Elect*
Tampa, Fla.
Dr. L. George Parry, *Vice-President*
Atlanta, Ga.
Dr. Ralph Durham, *Secretary-Treasurer*
Macon, Ga.

The Graduate School of Medicine of the University of Pennsylvania announces a new sixteen month course in Orthodontics beginning Sept. 9, 1953. For further information, write to the Dean, Graduate School of Medicine, 237 Medical Laboratories, Philadelphia 4, Pa.

The Indiana University School of Dentistry announces a one week post-graduate course in Crown and Bridge Prosthesis, Oct. 19 to 23, 1953. For further information write to Dean Maynard K. Hine, Indiana University School of Dentistry, 1121 W. Michigan St., Indianapolis, Ind.

The next Greater New York Dental Meeting will be held at the Hotel Statler, Dec. 7, 8, 9, 10, and 11, 1953.

The 28th Italian Congress of Stomatology will be held in Bari, Italy, October 13 to 17, 1953. Topics to be dealt with by the Congress are: (1) "The Focal Dental Infection." Speakers: Prof. Lusena, Milan; Prof. B. Mela, Turin. (2) "Economic and Social Handicaps Arising from Dental Caries." Speakers: Prof. G. Briasco, Genoa; Prof. L. Molfino, Genoa. (3) "The Fixed Prosthesis." Speakers: Dr. F. Strini, Rome; Dr. Zuccoli, Florence. For further details please address inquiries to 28th CONGRESSO ITALIANO DI STOMATOLOGIA, Palazzo Ateneo, Bari, Italy.